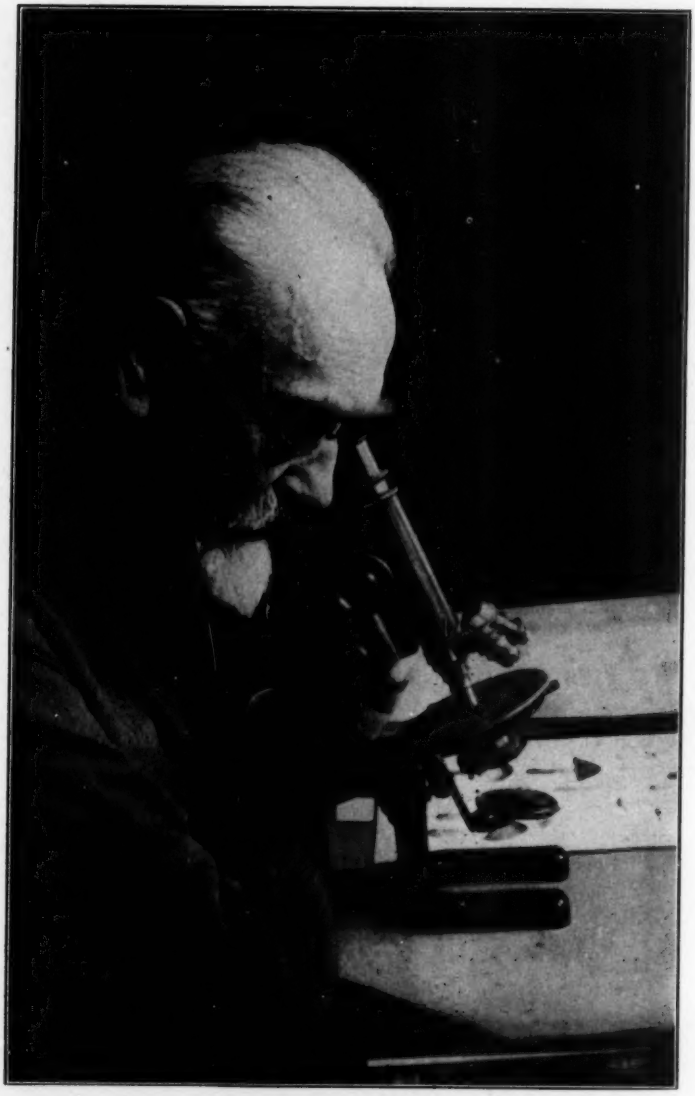

JAKOB E. LANGE (1864–1941).

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JAKOB E. LANGE

1864–1941

A. A. PEARSON

The fifth and last volume of Jakob E. Lange's *Flora Agaricina Danica* has now reached us. It was completed early in 1939 and published at Copenhagen during 1940. We also have received the sad news that the author of this fine work died rather suddenly after a few weeks illness on the 27th December 1941, while the German Army still occupied his country. Later the Germans made the Smallholders School near Odense, over which he presided for so many years, the headquarters of the Gestapo. This was the building that was so neatly picked out by the British Royal Air Force and sent to smithereens. Lange with a heavy heart and a wry smile would have approved, for he hated all that the Nazis stood for.

The last volume of his work, which we now peruse with so much satisfaction, completed an undertaking started by him in 1914 when he published in the *Dansk Botanisk Arkiv* the first of a series which he called "Studies in the Agarics of Denmark." The original purpose was to give accurate microscopic details of the agarics. Altogether, twelve of these "Studies" appeared, some with a colored plate. The last was issued in 1938.

Meanwhile he had received from his countrymen enough support to print the colored drawings which were on view at the Museum of the Botanic Garden, Copenhagen. Vol. I was printed

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in 1935 followed at regular intervals by others until the war drew a curtain between us and the author.

Jakob E. Lange was born on the 2 of April, 1864. He was the son of a clergyman living in the southern part of Jutland. The Germans, at the time, were in occupation of that part of the country. In the eighties he worked as a gardener and spent some time at Kew and Paris. After getting his degree from the Danish Agricultural College, he became a teacher in the college where he remained for 30 years teaching young farmers botany and social economics. He wrote books on botany and chemistry and in 1917 took over the direction of the Smallholders School, where small farmers sent their sons and daughters for a short course on agriculture and other subjects. Lange was also prominent in the social and political movements, being at one time a leader of the Danish liberal and radical party. In the midst of these activities he found time to write a popular illustrated book on wild flowers designed for children, which had a sale of nearly 200,000 copies, and he also wrote some popular books on social economics.

But his main interest, apart from his professional activities, was the study of the agarics. Some of his early paintings are dated 1893. His first paper in 1914 dealt with the genus *Mycena* and his division of the species into two groups based on their cystidia was a new approach to the subject which put the study of this genus on a sound basis. Von Höhnel in 1913 had published in Vienna something much on the same lines though in a less practical manner, but it would not appear that Lange had any knowledge of this paper at the time. However Von Höhnel was too busy with other groups of fungi and Lange's paper remained the standard work until Kühner gave us his masterly book on the genus *Mycena* in 1938. The subsequent papers of Lange were not of equal importance but have proved of great assistance to agaricologists, especially in the study of *Coprinus, Lepiota, Psalliota, Psathyra,* etc.

It was due to a short notice on the *Mycena* paper that the writer of the present review came into contact with Lange, and carried on a correspondence with him for more than twenty years. He used to send me his manuscript and our letters mostly dealt with points of English idiom as applied to scientific papers and were often very diverting. Lange had a good command of the English language

and though he inevitably went wrong on minor points, his style was clear and concise. English speaking mycologists have every reason to be grateful for his adoption of English for his work on the Agarics. In dealing with his manuscript all that was necessary was to make occasional alterations in the twist of a sentence or the use of a word contrary to English, though not always, perhaps, to American usage. A good instance was the use of the word "sordid." In a diagnosis this word would be used to indicate color and Lange wanted to make frequent use of it in spite of the view that most English writers would maintain that it can only be used in a non-material sense. You can say a man has a sordid mind, but not a sordid nose or a sordid handkerchief! However, the best American dictionaries sanction its use in the manner employed by Lange.

Lange's views on classification were on the whole conservative, and he rarely departed from the Friesian taxonomy. The new outlook of the French mycologists did not appeal to him. It is true he adopted Quélet's *Rhodophyllus* for all the species with pink angular spores, but he retained the Friesian sub-divisions, so made no real change. He followed Ricken in adopting the three Friesian sections of *Hygrophorus* as separate genera, which however he based on the structure of the gill trama. He rarely introduced a new genus. *Paxillopsis,* which he used for a rather heterogeneous group of agarics with salmon colored spores, was not a happy venture. On the other hand he described many new species in the European fungus flora—over sixty without counting new varieties and forms. Some of these have since been found outside Denmark and a few inevitably have been identified with other species, but Lange was not an irresponsible species maker and most of his newly named agarics will be found to be valid. Latin diagnoses of new species together with a general index have been issued separately for binding with the last volume.

The colored plates which adorn the five volumes of the *Flora Agaricina Danica* are a great achievement both for the author and the printer. Lange recommended using a reading lens when examining the figures. The only criticism some of us would make is that the colors might be brighter. Lange erred on the side of delicacy in this respect, but these paintings are good and together

with the keys for each genus, are most useful in helping to run down a species. Of course the fungi were found in a relatively small area of Europe—in a country where trees are grown for their timber and the woods kept clear—in fact not at all the sort of paradise the mycologist dreams of, yet over a thousand species and many varieties and forms are illustrated. That is a very substantial proportion of the agarics to be found in Europe.

Lange came three times to the United States. The first occasion was in 1927 when he had little opportunity of looking at the fungi. In 1932 the second trip was made, and on that occasion he did a lot of collecting and wrote a short account of his impressions of the North American Fungus Flora which appeared in Vol. **26**, p. 1–12 of *Mycologia*. It was here he made the remarkable statement that about 70 per cent of the species he met with could be identified with European species familiar to him.[1] The last American journey was in August 1939. He got home safely but the more extensive comparative study of the European and American agarics was not to come from his pen.

[1] When collecting in the Great Smoky Mts. National Park in 1939 he stated that although he recognized 70 per cent of the species he met in the Adirondacks as fungi which occurred in Europe, he did not know more than 30 per cent of those seen in the "Smokies."—Editor.

A NEMATODE-STRANGLING DACTYLELLA WITH BROAD QUADRISEPTATE CONIDIA

CHARLES DRECHSLER [1]

(WITH 2 FIGURES)

In earlier papers I have described under the binomials *Trichothecium polybrochum* (**6**: 535–538), *Arthrobotrys dactyloides* (**6**: 482–487), *Dactylella doedycoides* (**8**: 448–456), *Dactylella heterospora* (**9**: 339–349), *Dactylella bembicodes* (**6**: 487–492), and *Dactylaria brochopaga* (**6**: 514–518) six species of clampless nematode-capturing hyphomycetes which among predaceous fungi are especially remarkable through their utilization of stout hyphal rings by whose forcible contraction the prey is not only held securely but is at the same time strangled so severely that disablement soon follows, permitting early intrusion of assimilative filaments into the fleshy body. From resemblances in mycelium and asexual reproductive parts it is obvious that these species are closely related to one another as well as to a greater number of other clampless hyphomycetes likewise subsisting by capture of eelworms but using predaceous devices not operating in any large measure through constriction. To the same taxonomic kinship are manifestly referable also several forms that prey on amoebae (**4**), testaceous rhizopods (**3**, **5**, **7**), or insects (**11**). The predaceous apparatus employed by these forms in no instance operates by strangulation. Attack by strangulation is likewise wholly unknown in either of the two mainly terrestrial series of animal-capturing fungi taxonomically alien to the clampless hyphomycetes; such forcible attack not having come to light in the two nematode-capturing species of the clamp-bearing genus *Nematoctonus* (**13**), nor among the many predaceous members of the Zoöpagaceae, four

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of which are known to prey habitually on nematodes (**12**). Like the predaceous members of *Nematoctonus* and of the Zoöpagaceae the rotifer-capturing saprolegniaceous form *Sommerstorffia spinosa* Arn. (**1**) employs only adhesive organs in taking prey. However, occasional strangulation of rotifers in the constricting rings of *Dactylella bembicodes* has been recorded by both Couch (**2**: 309; pl. 27, fig. 14) and myself (**6**: 487, 488, 491, 492; 537, fig. 18, *N*); and subsequently I have observed rotifers captured also in the constricting rings of *Arthrobotrys dactyloides* and *Dactylaria brochopaga*.

A seventh species intimately akin to the six enumerated above, and displaying the same astonishing manner of capturing motile eelworms, recently made its appearance in a maizemeal-agar plate culture which after being permeated with mycelium of *Pythium arrhenomanes* Drechsl. had been further planted with a small quantity of friable leaf mold kindly supplied by R. K. Zuck, who gathered it from the floor of a beech (*Fagus grandifolia* Ehrh.) wood near Webster, N. Y., on September 20, 1945. The fungus was first noted 28 days after the forest detritus had been added. As the predaceous mycelium at the time extended scarcely 10 mm. out from the deposit of opaque material its development into the transparent agar could hardly have begun more than three or four days earlier. Considerable delay in extensive development could well have been occasioned by the originally hard consistency of the agar medium. Owing to this firm consistency movement of eelworms under the surface of the culture was naturally repressed until prolonged bacterial action had brought about noticeable softening; and until subsurface movement of prey took place freely the constricting rings of the new fungus, which like those of the six species previously described are commonly produced in submerged positions (FIG. 1, *A; B, a*), could have had only meager opportunity for effective operation. Whenever the fungus was transplanted to fairly soft agar cultures abundantly infested with eelworms, it has always been prompt in extending its predaceous mycelium in all directions.

The constricting rings of the New York fungus bear a close general resemblance to those of the six strangulating species described earlier. They are borne on relatively straight mycelial filaments

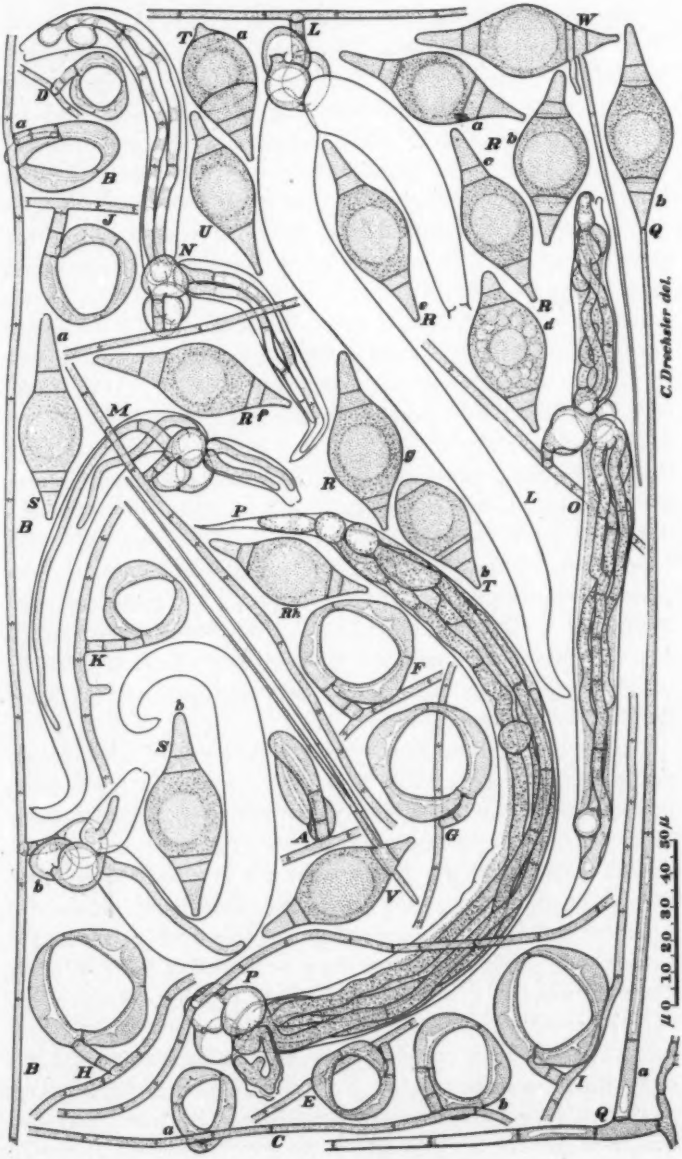

FIG. 1. *Dactylella coelobrocha.*

at intervals varying commonly from 25 μ (FIG. 1, *C, a, b;* FIG. 2, *A, a, b*) to more than 200 μ (FIG. 1, *B, a, b*). They are formed usually in a plane making a right angle with the parent filament (FIG. 1, *A; B, a*), and consequently in their original posture are usually seen edgewise or nearly edgewise. However, many of them later come to be directed flatwise to the observer, mainly from being jostled sideways by largish specimens of the nematodes they are designed to capture; and these displaced examples then more advantageously reveal the arrangement of their component cells. They are attached to the parent filament by a sturdy, usually two-celled stalk (FIG. 1, *C, a, b; D–J;* FIG. 2, *A, a, b; B–F*), and are made up regularly of three arcuate segments; the distal arcuate segment, as a rule, being fused both to the distal end of the second stalk cell and to the proximal end of the first arcuate segment (FIG. 1, *C, a, b; D–I; K;* FIG. 2, *A, a, b; B–F*). In somewhat exceptional instances the third arcuate segment may be anastomosed only with the second stalk cell (FIG. 1, *J*); or, again, the stalk may consist of three cylindrical cells (FIG. 1, *K*). The rings vary considerably with respect to size; the aperture in the smaller ones sometimes measuring only 12 μ across (FIG. 1, *D*), whereas in the larger ones it may measure 29 μ or 30 μ in greatest width (FIG. 1, *H*). Closure of the ring is accomplished, much as in rings of the six allied species, through contraction and centripetal swelling of the three arcuate cells (FIG. 2, *G*).

Despite their general resemblance to the rings of other species the predaceous organs of the New York fungus offer some modifications distinctive enough to merit attention. On the whole their component segments display somewhat more pronounced median thickening than the arcuate segments in allied forms. Further, the inner contour of the ring usually shows more pronounced curvature near the ends of the constituent cells than in their middle portions; so that the aperture here tends rather more strongly toward a rounded triangular outline than in other species. Yet, though the middle portion of the cell may show only slight curvature along the inner contour of the ring, it commonly lacks the curious median bulge whereby the aperture, particularly in rings of *Dactylella doedycoides* and *D. heterospora,* is given a scalloped outline suggestive, for example, of the trefoil ornamentation used

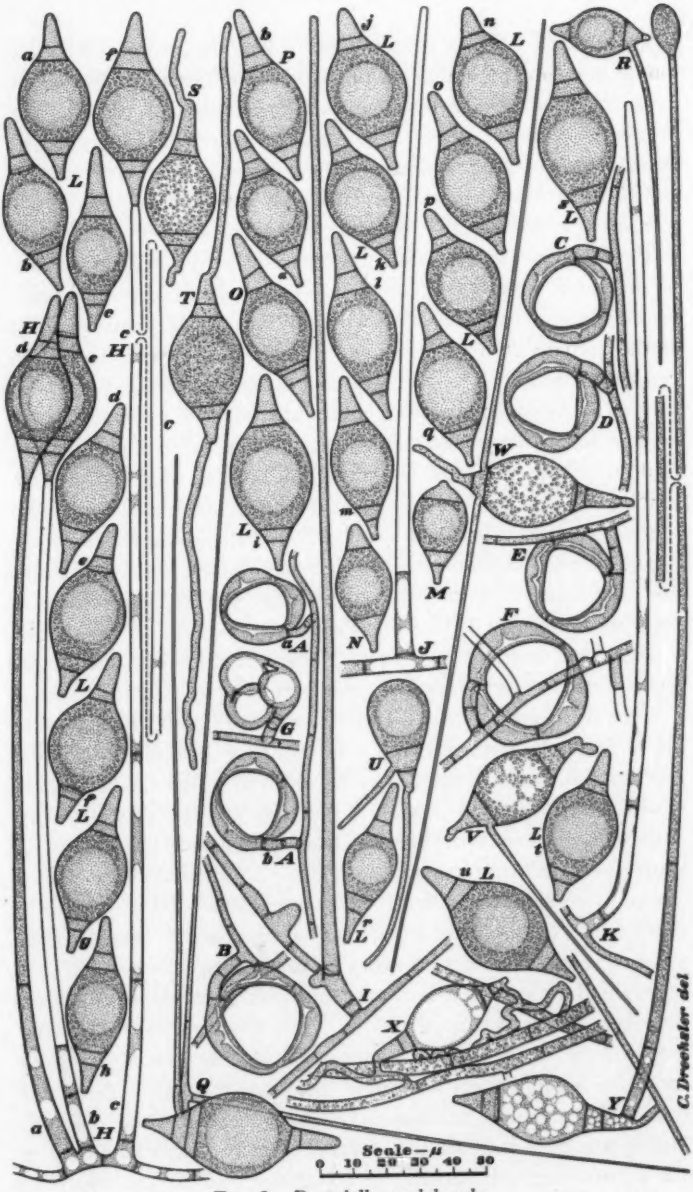

FIG. 2. *Dactylella coelobrocha.*

in architecture. In the present species, it is true, some perceptible modification in the outline of the aperture is often brought about by a slight bulging of the anastomosing connection between the proximal and distal arcuate segments. However, neither this connection nor the commonplace septal connection between the second and third arcuate cells shows much that could be held especially distinctive of the species. But the connection between the proximal and median arcuate cells presents marked peculiarity in narrowing to a width of 1.5 to 2.5 μ—to a width, therefore, often scarcely equivalent to one-third or one-fourth of the greatest width of the arcuate cells in question. Usually the narrowing of the two cells toward the septum dividing them is somewhat gradual, so that the connection often appears as a slender isthmus several microns long. In young predaceous organs capable of functioning vigorously the cross-wall in such an isthmus is often not clearly visible; the portion of the septum near the inner contour of the ring, together with the cell wall bordering the aperture, being, as a rule, wholly indiscernible to ordinary microscopical scrutiny. For that matter the other two transverse partitions in the ring likewise frequently fade from view in proximity to the inner contour, and even in proximity to the outer contour stand out less distinctly than the homologous partitions in related forms.

Since in predaceous organs that have closed, and in organs too old to function effectively, the cell membrane bounding the aperture, as also the cross-walls, appears much as in the similar organs of allied forms, there is reason to presume that the poor visibility of these membranous parts derives less from physical characteristics proper to them than from unusually dense consistency of the protoplasm in contact with them. The appearance of the bordering protoplasm, certainly, is suggestive of exceptional density. Besides, whereas the ring segments in the several other species are generally found occupied throughout with protoplasm of rather homogeneous aspect, in the New York fungus they show what would seem to be a narrow elongated vacuole extending longitudinally through them for nearly their entire length. When the open ring is viewed flatwise this vacuole is most often seen following a course more or less parallel to the concave boundary of the arcuate segment, usually at a distance of 1 to 2 μ from that

boundary. Over most of its length the vacuole commonly maintains a width of about 1 μ, but near the middle of the segment it usually widens out markedly in extending a wedge-shaped arm toward the outer contour of the ring (FIG. 1, *C, a, b; E; I; J;* FIG. 2, *A, a, b; C; F*), and in many segments the vacuole has two or three such arms (FIG. 1, *F–H;* FIG. 2, *B*). Occasionally the vacuole follows a more crooked course and then may in places lie nearly midway between the inner and outer boundaries of the ring segment (FIG. 1, *K;* FIG. 2, *E*). In segments where the vacuole occupies its more usual position, the denser protoplasm that tends to make membranous structures appear indistinct is localized especially in the narrow layer bordering the inner contour of the ring. After closure of the ring the swollen segments each reveal a large spherical vacuole (FIG. 1, *B, b; L–P;* FIG. 2, *G*) which could well have been formed from the elongated vacuole present earlier. However, as in the six allied species the swollen segments show similar internal organization, it is not evident that the elongate vacuole in the New York fungus causes any distinctive modification in the arrangement of cell contents after contraction has taken place.

The narrowed cord-like connection between the first and second arcuate segments makes for a curious modification in the operation of the predaceous organ. While in the six other strangulating species all three cells composing the ring press their broadened bulk directly into the animal's body and thus squeeze it with about equal violence from three sides, in the New York fungus the captured nematode is usually found gripped only by the first two cells, which in their swollen condition are interposed between the captive and the distal cell. As a rule the swollen portions of the first and second cells seem less deeply indented into the animal's body than are the three swollen cells of allied forms; strangulation here evidently being brought about for the most part through deep narrow indentation of the fleshy body by the slender cord-like connection. Manifestly the slender connection serves altogether in a passive manner. The pull whereby it constricts the eelworm so severely is supplied through the contraction of all three arcuate segments, for the distal cell obviously loses little in mechanical effectiveness from lack of direct contact with the captive. Since

the pressure put on one side of the animal by the swollen parts of the first and second cells is applied over a wider region than the opposing pressure exerted on the other side by their slender connection, both the forward and backward portions of the nematode are often abruptly bent away from the closed ring (FIG. 1, *B, b; L; N; P*). Consequently the captured animal, which here is commonly gripped near the periphery rather than in the center of the ring, shows more often than captives strangled by allied forms an unnatural angular posture resembling a little the posture usually taken in the hangman's noose. With this unpleasant device, indeed, the predaceous organ under consideration would seem to have some measure of real similarity.

When from increasing disablement the struggles of a captured nematode have been largely quieted, the two swollen cells directly in contact with the animal will push delicate processes through its integument into the underlying tissue; the processes after some enlargement growing lengthwise through musculature and organs (FIG. 1, *B, b; M*) until the fleshy interior is occupied from head to tail by assimilative hyphae (FIG. 1, *N–P*). Small slender eelworms measuring about 200 μ in length and 10 to 12 μ in width are usually permeated forward and backward by two such hyphae (FIG. 1, *M, N*); whereas stouter specimens measuring about 300 μ in length and 18 to 20 μ in width commonly reveal no less than four (FIG. 1, *P*). Branching of the assimilative filaments occurs, in the main, close to their origin from the swollen cells, but occasionally may also be observed in more remote positions. In most though not in all assimilative filaments the distal segment undergoes globose swelling (FIG. 1, *N*), and rather often the second cell from the tip, together at times with the third cell, likewise becomes distended in varying measure (FIG. 1, *O, P*). Similar terminal enlargement of absorptive hyphae was noted earlier in the allied strangulating species *Arthrobotrys dactyloides*. After completing their growth the assimilative filaments form additional cross-walls until they are divided into segments of only moderate length. During the period they are most active in appropriating the globuliferous degenerating contents of the animal host their protoplasm shows numerous small globules (FIG. 1, *O, P*). When the host materials approach exhaustion the hyphal contents become less and less globu-

liferous. Finally, after increasing vacuolization (FIG. 1, *N*), the remnants of nearly homogeneous fungus protoplasm are withdrawn from the assimilative elements by way of the swollen cells of the closed ring into the parent mycelial filament.

A tract of predaceous mycelium amply nourished through expropriation of many eelworms will usually soon put forth scattered conidial apparatus. Rather tall conidiophores, generally similar to to those of *Dactylella bembicodes,* though appreciably more slender, are produced, some in groups of two or three (FIG. 2, *H, a–c*), others singly at variable distances from their fellows (FIG. 1, *Q;* FIG. 2, *I–K*). Although the shorter conidiophores (FIG. 2, *H, a, b; J*) often measure only about 200 μ in length, the taller ones frequently attain a height of 450 μ (FIG. 2, *H, c*) and occasionally a height exceeding 500 μ. In some instances they produce their usually single conidium without forming any cross-wall above the septum regularly delimiting them at the base (FIG. 2, *I*), but more often one or two additional septa are deposited proximally (FIG. 1, *Q;* FIG. 2, *H, a–c; J; K*). Production of conidia plurally, either through subterminal branching or through renewed apical elongation after development of the first spore, seems relatively infrequent. However, when conidiophores that have produced a conidium fall over on the moist substratum, they often send up individually a new conidiophore from one of their stout basal cells (FIG. 1, *Q*), while the slenderer distal portions, if not previously evacuated of contents, usually grow out vegetatively like ordinary mycelial hyphae.

The conidia of the New York fungus are of the large broad type which, though unusual among the Mucedinaceae generally, is characteristic of many nematode-capturing hyphomycetes, including, indeed, four of the six constricting species made known earlier. With respect to septation and cellular make-up they differ decisively from the conidia of any of these four strangulating forms. In strong contrast to the uniseptate condition prevalent in spores of *Trichothecium polybrochum* and to the biseptate condition most common in the large conidia of *Dactylella doedycoides* as well as of *D. heterospora,* and in fairly pronounced contrast also to the triseptate condition typical of *D. bembicodes,* they show most frequently a symmetrically quadriseptate partitioning whereby the cell in median or penultimate position greatly exceeds the others with

respect to length, width, and volume (FIG. 1, *Q, b; R, a–h;* FIG. 2, *H, d–f; L, a–u*). Where abundant sporulation, accompanied by a high degree of uniformity in size and shape, gives ample assurance of normal development, 100 conidia chosen at random, whether from a nematode-infested culture or from a pure culture on maizemeal agar, are usually found to include eighty to eighty-five quadriseptate specimens whose distended middle segment is much larger than the two cells below it or than the two cells above it. In cellular make-up these quadriseptate conidia thus show similarity to the five-celled conidia of approximately equal length that predominate in the nematode-capturing hyphomycete I have referred (**6**: 492–496) to *Dactylella ellipsospora* Grove (**14**). However, whereas in this hyphomycete, which captures its prey by means of stalked adhesive knob-cells, the four smaller segments of symmetrically quadriseptate conidia differ rather little with respect to length, in the New York fungus the parabasal and penultimate segments are nearly always conspicuously shorter than the basal and apical segments. Further, the large median cell widens more pronouncedly in the New York fungus than in the knob-bearing species, giving the conidium a more strongly ventricose outline and a greater measurement in transverse diameter. The data on conidial dimensions included in the diagnosis below were derived from 100 symmetrically quadriseptate specimens taken at random in abundantly sporulating material. The 100 measurements for length, expressed in the nearest integral number of microns, showed a distribution as follows: 46 μ, 1; 47 μ, 2; 48 μ, 7; 49 μ, 3; 50 μ, 4; 51 μ, 13; 52 μ, 15; 53 μ, 8; 54 μ, 14; 55 μ, 6; 56 μ, 6; 57 μ, 4; 58 μ, 5; 59 μ, 1; 60 μ, 1; 61 μ, 4; 62 μ, 4; 63 μ, 1; 64 μ, 1; whereas the values for greatest width were distributed thus: 18 μ, 2; 19 μ, 6; 20 μ, 18; 21 μ, 40; 22 μ, 18; 23 μ, 7; 24 μ, 6; 25 μ, 3.

Among the conidia (FIG. 1, *S–U;* FIG. 2, *M–P*) not conforming to the symmetrically quadriseptate type most characteristic of the species, some are divided by five cross-walls into six cells; the additional cell appearing most often as a short segment between the short parabasal and massive antepenultimate segments (FIG. 1, *S, a, b;* FIG. 2, *O*), though occasionally it occurs in antepenultimate position directly above the massive cell (FIG. 2, *P, a, b*). More pronouncedly unsymmetrical septation is found in some quadriseptate

conidia where the massive cell lies in penultimate position above three smaller proximal cells (FIG. 1, *T, a, b*). Now and then a conidium contains only three cross-walls, with the massive cell either in penultimate (FIG. 2, *M*) or in antepenultimate FIG. 1, *U*) position, but in such instances, especially where the spore is of good size, the septation observed cannot always be regarded as definitive. The scattered biseptate conidia in which the massive cell commonly occupies a median position between a small basal cell and a small apical cell (FIG. 2, *N*) likewise invite suspicion as to their maturity.

In many cultures a large proportion—sometimes virtually all—of the conidia, while still borne aloft on the erect conidiophores, will give rise, mostly from the short parabasal segment, to delicate filamentous outgrowths in numbers commonly ranging from one to three (FIG. 1, *V, W;* FIG. 2, *Q, R*). As a rule these outgrowths are mostly simple and project out at approximately right angles to the longitudinal axis of the spore, yet some of them bear proximally a branch oriented parallel to the spore axis (FIG. 2, *Q*). Though commonly only 1.8 to 2.5 μ wide at the base they taper upward in easily noticeable degree; so that in well developed specimens 125 to 200 μ long a distal portion of considerable length may measure only 0.6 to 0.8 μ in width. When left undisturbed they usually keep a conspicuously stiff straight posture despite their unusual delicateness. Whereas the shorter outgrowths most often appear continuous throughout with the conidial segment from which they arise, those of greater length frequently contain one or two cross-walls in their stouter basal portions.

When conidia with small apical and basal segments fall on a moist substratum, they soon germinate by putting forth two germ hyphae about 2.5 μ wide; one of the hyphae being extended usually from the region immediately bordering the slightly flattened base, the other from the rounded apical region (FIG. 2, *S, T*). Production of a germ hypha from the usually small parabasal segment happens only occasionally, as, for example, in instances where the large massive cell is found in terminal position (FIG. 2, *U*). The presence of one or more finely tapering outgrowths on the parabasal segment does not seem to abate the general preference for bipolar germination (FIG. 2, *V, W*). Germ tubes from fallen co-

nidia anastomose freely with neighboring mycelial filaments (FIG. 2, *X, Y*); and, indeed, hyphal fusions of all sorts occur no less abundantly here than elsewhere in the series of clampless predaceous hyphomycetes. Much as in allied forms, again, conidia frequently send up a robust conidiophore whereon a secondary conidium is produced (FIG. 2, *Y*).

Emission of filamentous outgrowths from conidia that are still held aloft on the erect conidiophores is not at all infrequent among the other broad-spored nematode-capturing species of *Dactylella*, nor among the broad-spored predaceous species of *Dactylaria* such as *Dactylaria thaumasia* Drechsl. (**6**: 518–523) and *Dactylaria psychrophila* Drechsl. (**10**: 154–166). In these related species the outgrowths tend usually to intergrade more or less indistinguishably with germ hyphae and germ conidiophores. Although similar intergradation is observable likewise in the present fungus, the outgrowths here often become so distinctively differentiated that they present much the general appearance of setose appendages of the type familiar, for example, in *Alternaria Solani* (Ell. & Mart.) Sorauer.

The fungus was readily isolated by transferring conidia from erect conidiophores in nematode-infested cultures to poured plates of sterile agar medium; the transfer being accomplished conveniently by touching the tips of the conidiophores with a slice of agar held on a flamed platinum spatula. In pure culture on maizemeal agar a fairly dense submerged mycelium develops, which, owing to haphazard arrangement of the component filaments, is without the luster characteristic of *Arthrobotrys dactyloides* and *Dactylaria brochopaga* when cultivated under similar conditions. As many of the finer branches given off by the larger hyphae ramify rather extensively, the submerged mycelium offers a somewhat more delicate appearance than would seem commensurate with the fairly robust character of the conidial apparatus which after several days becomes macroscopically visible, together with interspersed aerial vegetative hyphae, as a scanty arachnoid weft.

In view of the curiously vacuolate condition of the arcuate cells making up its predaceous organs the fungus is described under a specific epithet compounded of two words meaning "hollow" and "noose," respectively.

Dactylella coelobrocha sp. nov.

Mycelium effusum; hyphis hyalinis, septatis, plerumque 1.4–5 μ crassis, hic illic ex ramulis bilocularibus (raro trilocularibus) vulgo 10–18 μ longis et 2.5–4.2 μ crassis laqueos circulares 20–40 μ latos proferentibus qui in 3 cellulis arcuatis 14–40 μ longis medio 3.5–8.5 μ crassis consistunt et foramen rotundum vel rotundo-triangulum 12–30 μ latum circumdant; cellulis in extremis fere coarctatis, copula inter primam et secundam praesertim angusta et plerumque tantum 1.5–2.5 μ crassa; quaque arcuata cellula in lato foramen juxta vacuolum elongatum habente; vermiculo nematoideo in laqueum apertum errato omnibus tribus cellulis arcuatis abrupte se contrahentibus tumentibusque, animal vulgo inter primam et secundam arripientibus, captivum copula angusta magnopere comprimentibus, id ita ad modum laquei carnificis necantibus, his duabus cellulis mox integumentum ejus perforantibus, hyphas int s evolventibus quae carnem exhauriunt; hyphis assumentibus mediocriter septatis, magnam partem 2.5–5 μ crassis sed saepius in cellulas 5–8 μ crassas abeuntibus. Hyphae fertiles incoloratae, erectae, prope basim 1–3 septatae, vulgo simplices, plerumque 200–500 μ altae, basi saepius 4–6 μ crassae, sursum leniter attenuatae, apice saepe 1.5–3 μ crassae, conidia singula ferentes, quandoque recrescentes et aliud conidium gignentibus. Conidiis incoloratis, plerumque late fusiformibus, medio valde inflatis, 2–5 septatis, saepissime 4 septis in 5 cellulas divisis tali modo ut cellula media (antepaenultima) multo grandior quam aliae sit, tum plerumque ex toto 46–64 μ (saepius circa 53.7 μ) longis et 18–25 μ (saepius circa 21.2 μ) crassis, cellula infima 5.4–13.7 μ (saepius circa 8.2 μ) longa, cellula secunda 2.6–5.7 μ (saepius circa 4.3 μ) longa, cellula media 21.4–30.8 μ (saepius circa 25.4 μ) longa, cellula paenultima 2.8–6.8 μ (saepius circa 4.5 μ) longa, cellula summa 6.7–15 μ (saepius circa 11.3 μ) longa; quandoque omnibus cellulis glabris, quandoque cellula secunda praecipue 1 usque 5 appendices filiformes ad pares angulos emittente; appendicibus incoloratis, rectis, aliquid rigidis, continuis vel prope basim 1–2 septatis, plerumque 50–200 μ longis, basi 1.8–2.5 μ crassis, sursum attenuatis, apice 0.6–0.8 μ crassis.

Vermiculos nematodeos diversos (*Plectum parvum* et species *Rhabditis* et *Wilsonematis* inter alia) capiens consumensque habitat in foliis *Fagi grandifoliae* putrescentibus prope Webster, New York.

Mycelium spreading; vegetative hyphae colorless, septate, mostly 1.4 to 5 μ wide, often especially in presence of nematodes producing mostly underneath and in perpendicular positions approximately circular rings measuring 20 to 40 μ in outside diameter and composed individually of three arcuate cells 14 to 40 μ long, 3.5 to 8.5 μ wide in the middle—the first and third of the cells regularly being united to each other as well as to the distal end of a somewhat curved two-celled (rarely three-celled) supporting stalk commonly 10 to 18 μ long and 2.5 to 4.2 μ wide; all three cells narrowing toward their delimiting septa, but the connection between the first and second being especially narrow, often measuring only 1.5 to 2.5 μ in width; each cell having an elongate vacuole, mostly near

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the side bordering the ring aperture; this aperture being of circular or rounded triangular shape, and varying from 12 to 30 μ in greatest width. After entrance of a nematode into the ring aperture all three arcuate cells abruptly contracting and swelling, thereby gripping the animal usually between the first and second cells, and through deep constriction brought about mainly by strong pull on the narrow cord-like connection strangling the captive somewhat as in a hangman's noose; the two cells then perforating the integument and extending lengthwise through the animal assimilative hyphae for the most part 2.5 to 5 μ wide but often terminating in cells 5 to 8 μ wide. Conidiophores colorless, erect, containing one to three cross-walls mostly in the basal portion, usually unbranched, commonly 200 to 500 μ high, 4 to 6 μ wide at the base, tapering gradually upward, often 1.5 to 3 μ wide at the tip, there bearing a single conidium and sometimes, on renewed elongation, a second conidium. Conidia colorless, mostly broadly fusiform and strongly ventricose in the middle, containing two to five septa, but most often divided by four cross-walls into five cells in such wise that the middle dolioform cell is much larger than the others,—then mostly 46 to 64 μ (average 53.7 μ) long and 18 to 25 μ (average 21.2 μ) wide, with the basal cell measuring often 5.4 to 13.7 μ (average 8.2 μ) in length, the parabasal cell 2.6 to 5.7 μ (average 4.3 μ), the median cell 21.4 to 30.8 μ (average 25.4 μ), the penultimate cell 2.8 to 6.8 μ (average 4.5 μ), and the apical cell 6.7 to 15 μ (average 11.3 μ); appendages sometimes wholly absent, but at other times present in numbers from one to five, usually arising from the short parabasal cell at right angles to the spore axis, colorless, filiform, straight, rather rigid, continuous or with one or two cross-walls in the basal portion, mostly 50 to 200 μ long, 2 to 2.5 μ wide at the base, tapering upward to a width of 0.6 to 0.8 μ in the distal portion.

Capturing and consuming nematodes of different species (*Plectus parvus, Rhabditis* spp., and *Wilsonema* sp. among others), it occurs in decaying leaves of *Fagus grandifolia* near Webster, N. Y.

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EXPLANATION OF FIGURES

FIG. 1. *Dactylella coelobrocha;* drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout. *A*, portion of hypha bearing a predaceous ring in normal position. *B*, mycelial hypha bearing two predaceous rings, *a* and *b*; one of the rings, *a*, being open and approximately in normal position; the other ring, *b*, having closed on a specimen of *Plectus parvus* and intruded two young assimilative hyphae into its body. *C*, portion of mycelial hypha bearing two open predaceous rings, *a* and *b*, oriented flatwise. *D–I*, portions of mycelial hyphae, each bearing an open predaceous ring oriented flatwise; the several rings collectively showing usual variations in size and shape. *J*, portion of mycelial hypha with a predaceous ring oriented flatwise; the distal arcuate segment here being attached only to the distal cell of the stalk, not to the proximal arcuate segment. *K*, portion of mycelial hypha with a predaceous ring oriented flatwise; the stalk consisting of three segments. *L*, portion of mycelial hypha bearing a predaceous ring that has closed on a specimen of *Wilsonema* sp. *M*, portion of mycelial hypha bearing a predaceous ring that has closed on a specimen of *Plectus parvus;* from the ring two assimilative hyphae are growing forward, and two others are growing backward through the fleshy body. *N*, portion of hypha with a predaceous ring that has closed on a specimen of *Plectus parvus;* the two assimilative hyphae extending forward like the two others extending backward have become strongly vacuolate as the host contents ap-

proached exhaustion; the two assimilative hyphae extending forward show the expanded terminations usual for the species. *O*, portion of mycelial hypha with a predaceous ring that has closed on a specimen of *Plectus parvus;* all the longer assimilative hyphae have swollen terminations. *P*, portion of hypha with a predaceous ring that has closed on a specimen of *Rhabditis* sp.; the four assimilative hyphae extended backward in the animal terminate individually in one to three distended segments. *Q*, prostrate hypha that has given rise to an erect conidiophore, *a*, whereon is borne a quadriseptate conidium, *b*. *R*, eight quadriseptate conidia, *a–h*, of the symmetrical cellular make-up most usual for the fungus. *S*, two quinqueseptate conidia, *a* and *b*, each with its swollen antepenultimate cell placed above three small proximal cells. *T*, two quadriseptate conidia, *a* and *b*, in which the massive cell is found in penultimate position. *U*, triseptate conidium whose massive cell lies between two smaller distal cells and a smaller basal cell. *V*, conidium whose parabasal cell bears three appendages, of which two are stiff and hair-like. *W*, quinqueseptate conidium bearing a filamentous appendage on its parabasal cell and a short hyphal outgrowth on the discoid third cell.

FIG. 2. *Dactylella coelobrocha;* drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout. *A*, portion of hypha bearing two open predaceous rings, *a* and *b*, which are turned flatwise. *B–F*, portions of mycelial hyphae, each with an open predaceous ring turned flatwise; the several rings collectively showing usual variations in size and shape. *G*, predaceous ring that has closed without capturing an eelworm. *H*, group of three conidiophores, *a–c*, bearing the solitary conidia *d–f*, respectively; owing to lack of space the conidiophore *c* is shown in parts whose proper continuity is indicated by broken lines. *I–K*, denuded conidiophores. *L*, twenty-one quadriseptate conidia, *a–u*, of the symmetrical cellular composition most usual for the fungus. *M*, small triseptate conidium whose largest cell lies between two small proximal cells and a small apical cell. *N*, small biseptate conidium with its massive cell in median position. *O*, quinqueseptate conidium wherein the massive antepenultimate cell is placed above three smaller proximal cells. *P*, two quinqueseptate conidia, *a* and *b*, wherein the massive cell is placed between two small proximal cells and three small distal cells. *Q*, large quinqueseptate conidium whose small parabasal cell bears two long, stiff setose appendages, one of which is branched near the base. *R*, small triseptate conidium whose parabasal cell bears a single setose outgrowth. *S*, *T*, quadriseptate conidia of symmetrical make-up, each germinating by production of a germ tube from each end. *U*, biseptate conidium which, owing to lack of a small apical cell, is putting forth a germ tube from the small parabasal cell as well as from the small basal cell. *V*, bipolar germination of a symmetrically quadriseptate conidium bearing a setose outgrowth on its small parabasal segment. *W*, bipolar germination of a symmetrically quadriseptate conidium bearing two long setose outgrowths on its small parabasal cell. *X*, conidium that has put forth a germ tube from near each of its ends, both germ tubes having very soon fused with mycelial hyphae nearby. *Y*, a fallen conidium whose apical cell has put forth a young erect conidiophore as well as a vegetative germ tube that soon anastomosed with a mycelial filament; owing to lack of space the conidiophore is shown in parts whose proper continuity is indicated by broken lines.

STUDIES IN THE GENUS INOCYBE. I. NEW AND NOTEWORTHY SPECIES FROM WASHINGTON *

D. E. STUNTZ

(WITH 50 FIGURES)

The abundant and varied agaric flora of Washington includes many interesting species of the genus *Inocybe*. Some of these have not been reported from the United States before, others have not been found previously in Washington, and still others cannot be identified satisfactorily with any of the American or European species. During the course of a study of *Inocybe* which has been in progress for several years, some species in each of the above categories have been found. Twenty of these are presented in this paper. Many others are included in my collections, awaiting further study, and continued field work is expected to add to the number.

The species presented in this paper were collected during the years from 1934 to 1940. All collections have been deposited in the herbarium of the University of Washington at Seattle, Washington, and where the material permitted, portions of the types of new species have been deposited in the herbarium of the University of Michigan. Collection numbers given in parentheses after the locality are my own. The symbol (R) following a color name indicates that the name is from Ridgway, Color Standards and Color Nomenclature (**12**) : a color name followed by a number in parentheses (*i.e.*, snuff brown (303)t.–1) is from the Répertoire de Couleurs (**11**). All drawings of microscopic characters were made with a camera lucida, at an initial magnification of 1720 diameters for the pleurocystidia, cheilocystidia, and sterile cells, and 3625 diameters for the spores, and reduced approximately

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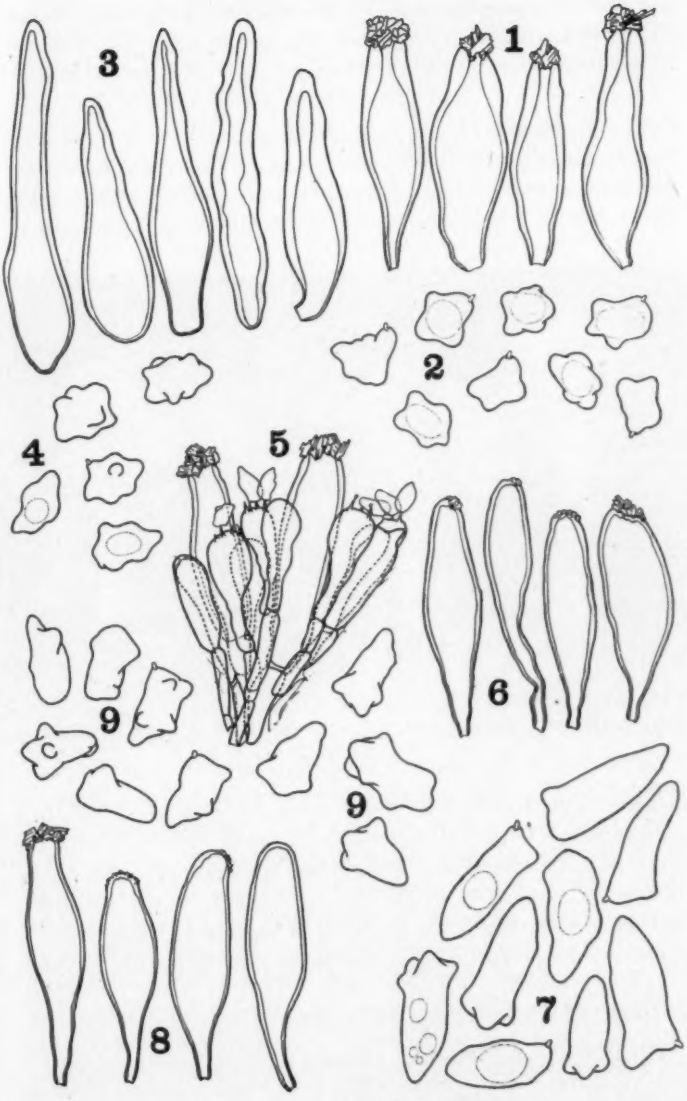
one-half in printing. Grateful acknowledgment is made to Dr. W. M. Read of the University of Washington, for assistance in the preparation of the Latin descriptions.

1. INOCYBE ALBODISCA Pk. (FIGS. 1, 2, 45)

PILEUS 2–4 cm. broad, campanulate, becoming expanded and umbonate, or remaining campanulate, margin persistently incurved, surface lubricous or subviscid when moist, soon drying subshining, smooth, glabrous, a little rimulose at the margin when mature; color white to ivory or cream colored at the center, the margin ecru drab (R) to pale vinaceous drab (R); context thick at the center, firm, white, unchanging; odor spermatic, strong. LAMELLAE adnexed, often slightly uncinate, rounded at the stipe and the cap margin, ventricose, fairly broad, about 5 × 15 mm., close to crowded; color white or pale gray, becoming wood brown (R). STIPE 3–6 cm. long, 4–7 mm. thick, cylindric or flattened, equal above the large, abruptly emarginate bulb; firm, rigid, solid, the context pallid, unchanging; surface everywhere densely white-pruinose, satiny under this covering; color pallid below, vinaceous-buff (R) or distinctly tinged fawn color (R) upward. SPORES 4–6 × 6–7.5 μ, angular-nodulose, with a few (6 to 8) low, rounded nodules at the angles. PLEUROCYSTIDIA 14–19.5(22) × 56–70 μ, numerous, fusiform-ventricose, very thick-walled apically, the pedicel short and thick or almost lacking; CHEILOCYSTIDIA numerous, more or less evenly distributed along the edge, same size and shape as the pleurocystidia. STERILE CELLS not very numerous, small, clavate, mingled with basidia. TRAMA OF LAMELLAE quite compact, homogeneous, the cells mostly cylindric or somewhat inflated-cylindric, with many slender hyphae present.

In sandy soil along a road through a stand of hemlock, Point Wells, Snohomish County, October 18, 1935 (*379*).

My specimens check exactly with those of many collections of *Inocybe albodisca* Pk. in the herbarium of the University of Michigan. This very distinctive species seems to occur rather commonly in open places in coniferous woods in Washington. It is easily identified by its lubricous pileus with cream colored center and brownish vinaceous or incarnate-vinaceous margin, and its long, rigid, incarnate, densely pruinose stipe, furnished with an abruptly emarginate bulb at the base. It is a typical example of the section Marginatae as defined by Boursier and Kühner (2).



FIGS. 1–9. Species of *Inocybe*.

Kühner (**9**, p. 101) cites *Inocybe albodisca* Peck and *I. hiulca* Fr. sensu Bresadola as synonyms of *I. grammata* Quél., which he interprets in the same manner as does Lange. On the other hand, Heim (**5**, pp. 314, 315) gives the name *I. grammata* Quél. to a quite different species, which he says is the same as *I. Bresadolae* Massee sensu Konrad & Maublanc (**8**, pl. 107). Heim also states that his *I. grammata* Quél. is the same as *I. grammata* Quél. sensu Lange and *I. hiulca* Fr. sensu Bresadola. Such differences in

FIG. 45. *Inocybe albodisca* Pk., × 1. The numbered divisions on the scale are centimeters.

opinion make it difficult to decide what name to use. Although the specimens of my collection No. 379 agree very well with the illustration and description of *I. grammata* Quél. given by Lange (**10**, p. 86, Tab. 116, fig. D) and by Kühner (**9**, pp. 101–104), and those of *I. hiulca* Fr. given by Bresadola (**3**, Tab. 762), I prefer for the present to apply the name *I. albodisca* Pk. to them.

2. INOCYBE CASTANEA Pk. (FIGS. 3, 4)

PILEUS 2.5–3 cm. broad, obtusely campanulate, becoming expanded, plane, always with a small rounded umbo, margin rounded; surface somewhat lubricous when moist, drying readily, smooth and unbroken at the center, rather coarsely rimose at the margin,

sometimes slightly to plainly diffracted-scaly in between: color chestnut (R), bay (R), maroon(341)t.–1, or mineral brown (339)t.–1, 2, sometimes snuff brown (R) toward the margin; context 3 mm. at the center, hygrophanous, gray when moist, drying buff or brown, odor none or resinous, rather aromatic. LAMELLAE adnate, sinuate to abruptly rounded at the stipe, ventricose, the edges convex, notably white-fimbriate and finely eroded; broad, about 4 × 12 mm., close, thin, of several lengths; color Dresden brown (R) to Prout's brown (R) or snuff brown (303) t.–1, 2. STIPE 2.5–3 cm. long, 4–5 mm. thick, cylindrical or flattened, equal or tapering slightly downward, not bulbous; solid, quite firm, the context brown; surface glabrous, satiny, the apex white-pruinose, the pruinosity sometimes extending to the base of the stipe; color snuff brown (303) t.–2 or tawny olive (R) to wood brown (R). SPORES 4.5–6.5 × 7.5–9 μ, merely angular to coarsely nodulose, the number of nodules 10 or less. PLEUROCYSTIDIA 10.5–21 × 55–85(97) μ, numerous, projecting prominently, slender, fusiform or lanceolate, usually absolutely sessile, with the base broadly rounded; thick-walled, especially apically. CHEILOCYSTIDIA numerous, projecting prominently, shaped like the pleurocystidia. STERILE CELLS abundant, in dense clusters, rather small, clavate. TRAMA OF LAMELLAE loosely arranged, the cells large, cylindric-inflated to ventricose or fusiform-clavate, varying in some lamellae, not in others.

On needle litter under Douglas fir and hemlock, Wells Point, Snohomish County, November 15, 1936 (*550, 556*).

The cystidia of *Inocybe castanea* Pk. are striking, with their lanceolate, thick-walled apex and broad, apedicellate, rounded base. Together with the small, obscurely angular spores and chestnut brown pileus, they serve to distinguish this species from the other brown nodulose-spored Inocybes.

The portion of the type collection of *Inocybe castanea* at the herbarium of the University of Michigan consists of three specimens, all of which are smaller and more slender than my plants, but which compare well with mine as to color, spores, and cystidia. A collection of *I. castanea* by Kauffman from Montana shows the same striking microscopic characters, and contains one specimen which is as large as mine. I feel free, therefore, to disregard the size limits of Kauffman's description (**7**, p. 238), and refer my specimens to Peck's species. This is the first report of *Inocybe castanea* Pk. from Washington.

3. **Inocybe chelanensis**, sp. nov. (FIG. 5–7)

Pileus 2–4 cm. latus, e campanulato convexo-expansus, siccus, centro sericeo-fibrillosus, pallide luteus vel cremeus vel fere albidus, margine fibrilloso-subrimosus, brunneo-vinaceus; caro alba, immutabilis; odor nullus vel vix raphaneus; lamellae rotundato-adnexae, subconfertae, latae, ex albis brunneo-olivaceae; stipes 1.5–4 cm. longus, 4–12 mm. crassus, equalis vel deorsum subattenuatus, solidus, glaber, longitudinaliter striatus, salmoneus vel brunneo-vinaceus; sporae 5.5–8 × 13–19 μ, crasse 4–5-tuberculatae, apice praelongus; pleurocystidia et cheilocystidia fusoidea vel subclavata, 13–20 × 50–90 μ. Specimen typicum legit prope Chesapeake Saddle, Chelan County, Wash., July 8, 1938, D. E. Stuntz n. *659*, pars in Herb. Univ. Wash., pars in Herb. Univ. Mich., conservatum.

PILEUS 2–4 cm. broad, convex to campanulate, becoming shallowly convex, finally almost plane; surface of young pileus completely covered with an appressed, pallid, silky coat which as the pileus expands remains at the center but disappears outward, revealing the lacerate-fibrillose, subrimose cuticle; color of center cinnamon buff (R) to pinkish buff (R), nearly white or pale cremeous in some, margin various shades of vinaceous brown, such as Rood's brown (R) or Mikado brown (R); in age the pileus tends to become discolored to shades of tawny olive (R); context thick (4 mm.) clear to the margin, there abruptly thin, firm, brown under the cuticle, elsewhere white, unchanging; odor almost none, very faintly raphanoid, taste mild. LAMELLAE adnexed to narrowly adnate, sinuate to deeply emarginate, rounded at both ends, ventricose, broad, 5 × 12 mm., edges convex, scarcely or not at all white-fimbriate; somewhat distant, rather thick, rigid; color at first white, becoming Dresden brown (R). STIPE 1.5–4 cm. long, 4–12 mm. thick, usually flattened, rarely cylindrical, equal or tapering downward a little, the apex dilated; solid, rigid, firm, the context white or with an incarnate tinge from the very first, slowly turning a little reddish where bruised; surface satiny, rather markedly longitudinally grammate, with superficial white silky fibrils below, the apex sparingly white-pruinose; color at first buff pink (R) to light vinaceous cinnamon (R), becoming vinaceous cinnamon (R) to orange cinnamon (R), tinged cacao brown (R) in age. CORTINA white, silky, very sparse and evanescent. SPORES 5.5–8 × 13–19 μ, most frequently 6.5 × 16 μ, distally prolonged into a smooth, bullet-shaped apex, bearing one to five large rounded nodules at the basal end, rarely with the entire outline angular or nodulose. PLEUROCYSTIDIA 12.5–19.5 × 50–90 μ, fusiform to clavate, thin-walled, not abundant, deeply embedded in the hymenium, from which they project only 20–25 μ. CHEILOCYSTIDIA same size and shape as the pleuro-

cystidia, not abundant, deeply embedded in the edge of the lamella. STERILE CELLS lacking, the edge of the lamellae fertile, composed of normal hymenial elements. TRAMA OF LAMELLAE very compact, homogeneous, of long, narrow cells which are cylindrical to narrowly fusiform, predominantly the latter. No lactifers seen. Subhymenium deep, cellular.

Gregarious on needles and mineral soil under *Abies* spp. and *Pinus contorta* Loud., Chesapeake Saddle, Chelan County, elevation 6000 ft., July 8, 1938 (*659*, type).

Unique spores distinguish this species from other Inocybes. In the course of their development, the distal half becomes greatly prolonged, remaining smooth, while a few large, round, low nodules develop subsequently at the basal end only. Occasionally the spore develops no nodules, but acquires a sinuous or angular outline, and rarely nodules are developed over the whole surface. Other than its spores, the distinguishing characteristics of *Inocybe chelanensis* are the vinaceous-brown pileus with buff or cream colored center, and the stout, salmon colored to brownish vinaceous stipe. As far as I am able to determine, there are no other species of *Inocybe* to which *I. chelanensis* is closely related. Certain of the specimens of *I. brunnea* Quél. figured by Heim (**5**, pl. XV, fig. 1) look not unlike my plant, but the resemblance is purely superficial. The spores of *Inocybe Rennyi* Berk. & Br. resemble those of *I. chelanensis* in fundamental nature and course of development, but in other respects the two species are quite dissimilar.

4. INOCYBE CICATRICATA Ellis & Ev. (FIGS. 8, 9)

PILEUS up to 2.5 cm. broad, campanulate, becoming obtusely campanulate, umbonate, margin rounded, surface innately radially silky, with a rather thick cuticle, remaining smooth; color when young otter brown (354) t.–4, becoming raw umber (301) t.–1 in age; context 3 mm. at the center, hygrophanous, brown under the cuticle, elsewhere yellowish, odor faintly spermatic. LAMELLAE broadly adnate, decurrent by a short tooth, shallowly sinuate, rounded at the margin, convex, broad, about 5 × 11 mm., subdistant, of two lengths; color smoke grey (363) t.–1, becoming snuff brown (303) t.–1. STIPE 4 cm. long, 5 mm. thick, cylindrical, equal, the base not bulbous, solid; surface satiny, with a few superficial fibrils at the apex (which is not pruinose) and base, color brownish terra cotta (322) t.–1 above, shading into raw

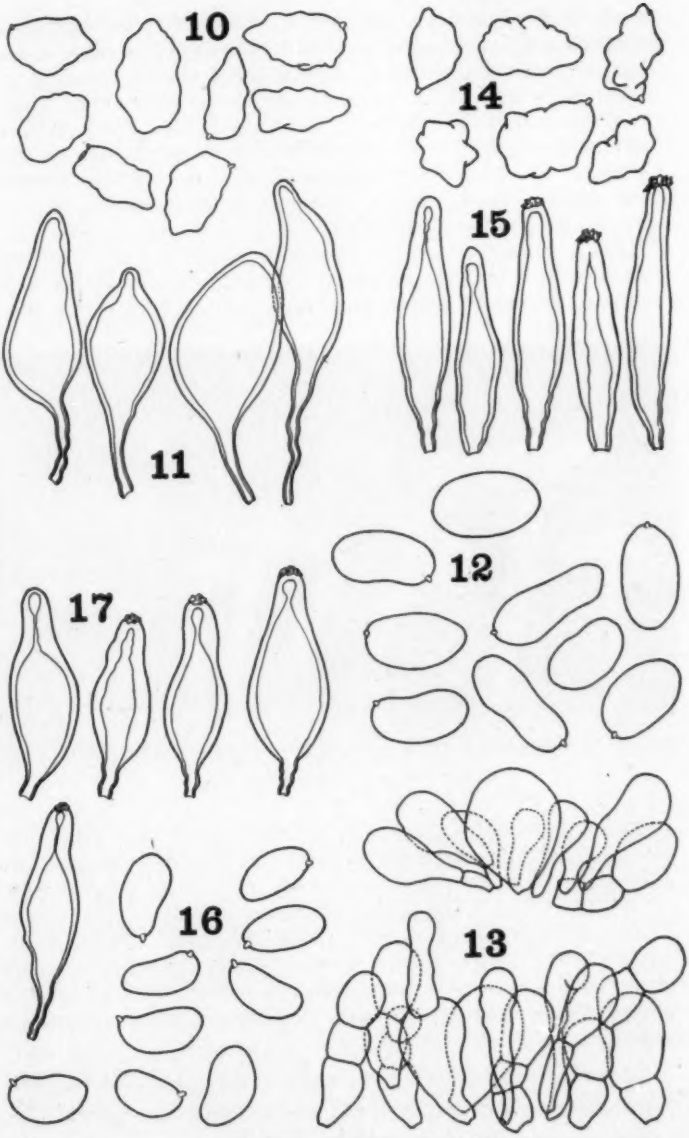
umber at the base. SPORES 5.5–6.5(8) × 9.5–12 μ, angular-nodulose, very polymorphic, trapezoidal, oblong, or triangular in outline, usually with the apex prolonged into a long tapering nodule, elsewhere with 5 to 8 coarse, irregular nodules which often distort the outline of the spore into very irregular shapes. PLEUROCYSTIDIA 14.5–19.5 × 53–65–75 μ, not very numerous, fusiform-ventricose to fusiform-clavate above a long slender pedicel, neck lacking or only very slightly differentiated, thin-walled, the wall sometimes slightly thickened apically, hyaline. CHEILOCYSTIDIA numerous, scattered along the edge, a few projecting prominently, resembling the pleurocystidia in size and shape, except that most of them have yellow contents. STERILE CELLS numerous, clustered along the edge, with basidia sometimes intermingled, narrow, clavate. TRAMA OF LAMELLAE compact, homogeneous, the cells of medium size, inflated-cylindrical, sometimes with a median constriction, sometimes somewhat fusiform. Lactifers infrequent, branched.

On needle litter under Douglas-fir, Fort Lewis, June 25, 1937 (*591*).

This collection agrees quite well with Heim's description of *Inocybe cicatricata* Ellis & Ev. (**5**, p. 351). The distinguishing characteristics are the small size, grey-brown pileus, solid dark brown stipe, and coarsely angular-nodulose, polymorphic spores, with a prominent distal elongation. This species has not been reported previously from west of the Rocky Mountains.

5. INOCYBE DECIPIENTOIDES Pk. (FIGS. 10, 11, 46)

PILEUS 1–3.5 cm. broad, campanulate, becoming expanded, convex, finally centrally depressed, always with a very prominent mammiform umbo; surface innately radially silky, satiny-shining, the umbo remaining glabrous, becoming rimulose to rimose toward the margin, or remaining silky-smooth, occasionally with a few appressed silky squamules between center and margin; color of the umbo persistently dark brown, umber, elsewhere buff or brownish ocher or fawn color, wood brown (R), the margin sometimes rather light, almost cream color; context thick at the center, elsewhere thin, firm, white, unchanging, odor spermatic, strong. LAMELLAE adnexed to squarely adnate, often uncinate, subdistant, sinuate, narrowing toward the margin, rather broad, 3–4 mm., edges convex, white-fimbriate; color at first white, long remaining so, becoming gradually pale grayish brown, finally brownish ochraceous. STIPE 4–5 cm. long, 5–7 mm. thick, cylin-



FIGS. 10–17. Species of *Inocybe*.

drical, usually tapering downward, the base never bulbous; solid or stuffed below, often spirally twisted, context fragile, white above, soon becoming brown below; surface satiny-shining, bearing the persistent remains of the copious white cortina above, apex white-pruinose; color pallid to cream color above, buff below at first, soon becoming dark brown at the base, sometimes with an obscure vinaceous tinge. SPORES (4.5)5–7(8) × 8–11(13) μ, varying from merely slightly angular to having 6 to 10 round, low, inconspicuous nodules. PLEUROCYSTIDIA 16–30(36) × 43–72(78) μ, mostly 20 × 55 μ, abundant, mostly inflated-fusiform-clavate above a long slender pedicel, varying considerably in shape and size, sometimes almost mucronate, varying from rather thin-

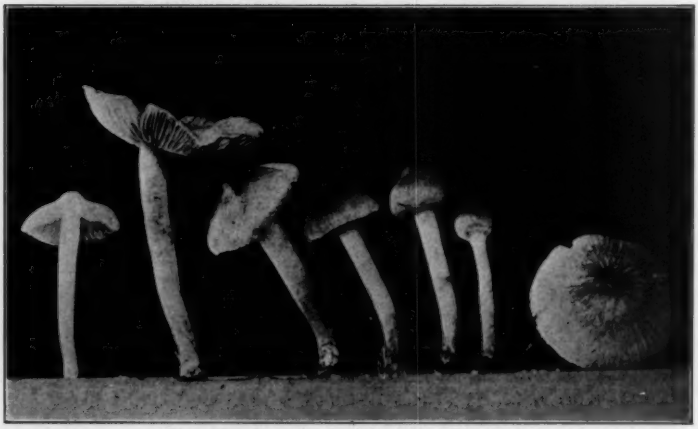


FIG. 46. *Inocybe decipientoides* Pk., × 1.

walled to thick-walled laterally or apically. CHEILOCYSTIDIA very abundant, densely crowded along the completely sterile edge, polymorphic like the pleurocystidia but of the same general type. STERILE CELLS few, large and clavate, closely resembling the immature cheilocystidia except for their thin wall. TRAMA OF LAMELLAE loosely woven, extremely heterogeneous, with all sizes and shapes of cells, from enormous inflated-fusiform ones to small, slender connective tissue; lactifers occurring frequently, especially in the subhymenium.

Gregarious in grass on a lawn, near a single tree of *Abies grandis* Lind., Seattle, April 21, 1934, and several years subsequently (*2*).

The silky-shining pileus with its dark brown prominent umbo

and paler margin, the persistently white lamellae, the slender, satiny stipe which turns brown at the base, are all macroscopic characters which distinguish *Inocybe decipientoides* Pk. Microscopically it is readily recognized by its angular, scarcely nodulose spores and broad, fusiform-clavate cystidia. Boursier and Kühner (2, p. 141) make *Inocybe globocystis* Vel. a synonym of this species, a procedure which seems to be justified if one may judge from the description and illustrations of *I. globocystis* given by Heim in his monograph.

6. INOCYBE DULCAMARA (Fr.) Quél. (FIGS. 12, 13)

PILEUS 6.5 cm. broad, shallowly convex, not at all umbonate, margin slightly revolute, wavy, entire; surface dry, entirely covered with tiny recurved hairy squamules from center to margin; color brownish terra cotta (332) t.–3 to Mars yellow (310) t.–4, toward the margin tinged with snuff brown (303) t.–2; context 8 mm. at the center, compact, pale ochraceous, odor faint, a little raphanoid, taste slightly bitter. LAMELLAE adnexed, some narrowly adnate, rather deeply rounded at the stipe, bluntly so at the margin, ventricose, broad, 11 × 25 mm., edges convex, not white-fimbriate, concolorous or discoloring dark brown; subdistant, transversely ridged at the base, sometimes a little intervenose; color a little paler than golden bronze green (298) t.–1. STIPE 3 cm. long, 8 mm. thick, cylindrical, equal, flaring a little at the apex, hollow, the context fibrous, tough, ochraceous, unchanging; surface longitudinally fibrillose, a little strigose below, the apex not pruinose but finely flocculose; color snuff brown (303) t.–2, 3. SPORES 5–7 × 9–13.5(14.5, 17.5) μ, mostly oval or subreniform, but rather variable in shape, some long and narrow. PLEUROCYSTIDIA and CHEILOCYSTIDIA lacking. STERILE CELLS fairly numerous, clustered along the edge of the lamella, large, clavate or saccate, frequently septate. TRAMA OF LAMELLAE fairly compact but very scissile, heterogeneous, the cells mostly long and slender, inflated-cylindrical usually with a median constriction; many slender hyphae present. Lactifers occasional, long, slender, unbranched.

On moss, along a stream in woods of *Abies* spp. and *Pinus contorta* Loud., Chesapeake Saddle, Chelan County, elevation 6000 ft., August 28, 1939 (*805*).

This *Inocybe* is easily recognized by its pileus which is entirely covered with small, tawny, pilose squarrulae, by its brownish-ocher

hollow stipe, broad olivaceous brown lamellae, and by its microscopic characters. I feel some hesitancy in referring it to *Inocybe dulcamara* (Fr.) Quél., a species about which European mycologists are not in agreement. The spores of my plant are a little longer and more variable than described for *I. dulcamara* by either Heim or Lange, but in other respects my specimen agrees quite well with the descriptions and illustrations (**5**, pl. V, fig. 4, and **10**, tab. 114, fig. C) given by these authors.

To judge from the infrequency with which *I. dulcamara* is mentioned by American mycologists, it is a very rare species in the United States. Kauffman does not report it in North American Flora, and I did not find any collections of it in the herbarium at the University of Michigan. This is the first report of it from west of the Rocky Mountains.

7. INOCYBE FULVELLA Bres., sensu A. H. Smith, Heim. (FIGS. 14, 15)

PILEUS 5–13 mm. broad, campanulate, remaining so or expanding somewhat, always umbonate, margin rounded, rarely plane or slightly recurved; surface glabrous at the center, elsewhere with numerous small, diffracted, fibrillose squamules, less often lanuginose or rimose; color tawny (R), ochraceous tawny (R), or russet (R) at the center, buckthorn brown (R) or ochraceous buff (R) toward the margin; context 2–3 mm. at the center, very thin at the margin, pallid brown, hyprophanous, odor spermatic. LAMELLAE adnexed to narrowly adnate, broadly rounded at the margin, narrowed toward the stipe, deeply ventricose, very broad, about 3 × 5 mm., edges convex, minutely pallid-fimbriate; subdistant, moderately thick, of several lengths; color tawny olive (R) or snuff brown (303) t.–1. STIPE 12–25 mm. long, 1–2.5 mm. thick, cylindrical, equal, base not bulbous; solid or stuffed or narrowly fistulose, the context reddish, fragile; surface at first entirely densely white-pruinose, glabrescent and satiny except at the apex; color light pinkish cinnamon (R) to pinkish cinnamon (R) or pinkish buff (R) to cinnamon buff (R), or a pale shade of tawny olive (R), paler at the apex, which may be either white or somewhat incarnate. SPORES 5–7(8.5) × 8–11.5(12) μ, elliptic-angular, with 8 to 12 or 14 more or less prominent rounded nodules. PLEUROCYSTIDIA 11–23 × 40–65(70) μ, abundant, narrowly fusiform, with no neck, sessile or with a very broad, short pedicel; very thick-walled laterally and apically. CHEILO–

CYSTIDIA abundant, occurring singly or in clusters, same shape and size as the pleurocystidia. STERILE CELLS numerous, densely clustered with the cheilocystidia, large and clavate, altogether lacking along some edges, which in consequence are fertile. TRAMA OF LAMELLAE not very compact, rather heterogeneous, the cells mostly large, fusiform-ventricose, varying considerably in size, with many slender hyphae present. Lactifers few and inconspicuous, small, threadlike, in the subhymenium.

In moss on the ground under Douglas fir, Fort Lewis, May 16, 1936 (*442*); in *Polytrichum* sp. and on bare earth, along a road through dense second growth conifers, near Chase Lake, Snohomish County, May 20, 1937 (*585*).

My collections were compared with some referred by A. H. Smith to *Inocybe fulvella* Bres., and were found to match them in every detail except one. Smith describes his specimens as having the lamellae at first "near avellaneous (R)," and the apex of the stipe army brown (R), whereas my plants lack any such brownish vinaceous colors. In this respect they are closer to *I. fulvella* as interpreted by Heim (**5**, p. 322). It seems to me that the limits of Bresadola's species are being made rather vague by the inclusion of forms (my own collections not excepted) which are rather divergent in the matter of color and spore size, and that it might be better to segregate these forms into another species. Such a procedure, however, is not advisable until further data on the variability of these plants can be obtained. The distinguishing characteristics of *Inocybe fulvella* as here understood are its very small size, tawny fibrillose pileus, very broad lamellae, pruinose pinkish buff stipe, large nodulose spores, and thick-walled, slender, fusiform cystidia. The large spores separate it from *Inocybe petiginosa*, (Fr.) Gill. to which it is closely related.

8. INOCYBE GEOPHYLLA Fr. (Quél.) var. LATERITIA Weinm. (FIGS. 16, 17, 47)

Syn.: *Inocybe geophylla* Fr. forma *perplexa* Kauff., Papers of the Mich. Acad. of Sci., Arts, and Letters **5**: 134. 1925.

PILEUS 1–6 cm. broad, usually 3–4 cm., campanulate, becoming expanded and obtusely umbonate, surface lubricous when moist, soon dry, silky-smooth, shining; color at first pure white, in age

slightly ochraceous to nearly tawny olive (R) at the center, the whole pileus or parts of it slowly becoming flushed with salmon orange (R), bittersweet pink (R), apricot orange (R) or flesh ocher (R), sometimes at length entirely rufous (R), bittersweet orange (R) or flame scarlet (R); context 4–6 mm. at the center, white, usually slowly becoming reddish where exposed, odor strong, spermatic. LAMELLAE adnexed to adnate, more or less broadly rounded at both ends, ventricose, broad, the edges convex and white-fimbriate, color at first white, becoming cinnamon brown (R) to snuff brown (303) t.–1. STIPE 5–10 cm. long, 4–10 mm. thick, cylindrical, equal, the base not or only slightly rounded-bulbous; solid or sometimes hollow at the apex, context white;

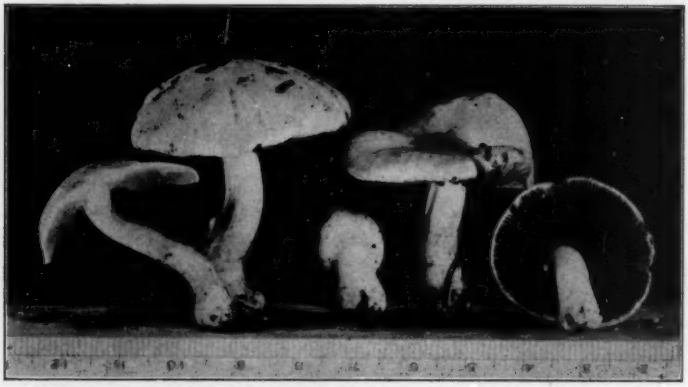


FIG. 47. *Inocybe geophylla* (Fr.) Quél. var. *lateritia* Weinm., × 1. Numbered divisions on the scale are centimeters.

surface glabrous, satiny, lubricous below when moist, apex densely white-pruinose; color white, becoming flushed like the pileus with salmon orange (R) or darker, often intensely so. SPORES 4.5–5 × 7–10.5 μ, entire, apex obtusely rounded. PLEUROCYSTIDIA 12–22(26) × 45–65(75) μ, very abundant, fusiform-ventricose with well developed pedicel and neck, thick-walled apically. CHEILOCYSTIDIA numerous, shaped like the pleurocystidia or more globular. STERILE CELLS abundant, clavate to globular, crowded along the sterile edge of the lamella. TRAMA OF LAMELLAE compact, homogeneous, the cells inflated-cylindric to fusiform. Lactifers very few.

In open grassy places under conifers, or on needle litter in conifer woods. Nisqually, October 30, 1934 (*217*); Seward Park,

Seattle, November 20, 1934 (*268*), December 20, 1936 (*570, 571, 572*); along the White River, October 17, 1935 (*397*); Wells Point, Snohomish County, October 14, 1936 (*507*), October 31, 1936 (*534*), November 15, 1936 (*542a*); Tenino Junction, Pierce County, October 25, 1936 (*528*); Clay Creek, White River road, November 8, 1936 (*542*).

The intensity and time of appearance of the red stains of pileus and stipe vary greatly; they may be already well developed by the time the sporocarp is mature, or they may not be evident until after the plants have been collected, or even until they are dried. From the above statement, it is evident that the form described by Kauffman as forma *perplexa* cannot be separated from the variety *lateritia* Weinm. In Washington this rubescent variety is very common; in fact, it is sometimes more abundant than the white form of *I. geophylla.*

The perplexing question of the relation of *Inocybe geophylla* var. *lateritia* to *I. Godeyi* Gill. still awaits a solution. According to Lange and Kauffman, the difference between them is chiefly one of size and stoutness of the sporocarp, which in *I. geophylla* var. *lateritia* is small and slender, with an acuminate pileus. If this distinction were applied, many of the Washington collections would be referred to *I. Godeyi,* as many of them are robust plants, with an obtusely umbonate pileus. However, in Washington the white form of *I. geophylla* varies in size and shape from small and slender to large and robust, and a similar variation occurs in the rubescent variety. Therefore it would be very hard to draw a line that would separate *I. geophylla* var. *lateritia* from *I. Godeyi* sensu Lange and Kauffman. I have examined a collection from Michigan which was identified by Kauffman as *I. Godeyi,* and found it to have spores that are broader and more gibbous dorsally than those of my plants. Also, Dr. A. H. Smith, who made the Michigan collection, said the sporocarps were more rapidly and intensely rubescent than any he had seen of *Inocybe geophylla* var. *lateritia.* I therefore prefer to use the latter name for the common rubescent *Inocybe* of Washington. It may be that the collection from Michigan represents *I. Godeyi* sensu Heim, which certainly differs in several respects from the descriptions of *I. Godeyi* given by Lange and Kauffman.

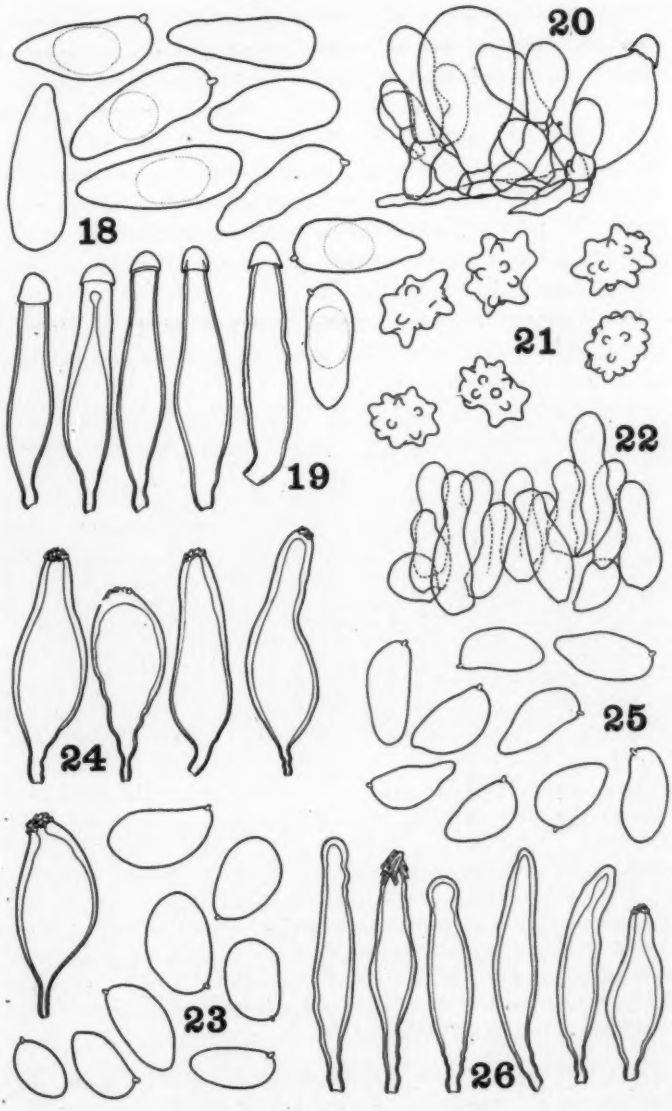
9. **Inocybe Hotsoniana,** sp. nov. (FIGS. 18–20)

Pileus 3.5 cm. latus, plano-expansus, late umbonatus, siccus, sericeo-fibrillosus, semper eodem modo fulvo-olivaceus; caro pallida, immutabilis; odor tenuiter raphaninus; lamellae late adnatae, subdistantes, 3–4 mm. latae, laete olivaceo-brunneae; stipes 6 cm. longus, 7 mm. crassus, aequalis, basis non bulbosus, solidus, appresso-fibrillosus, pileo concolor; sporae 5–7 × 12–20 μ, elongato-amygdaliformes vel cylindraceae; pleurocystidia et cheilocystidia abundantia, 12–17 × 60–82 μ, cylindraceo-subventricosa; apex crassitudine pileo simili praeditus. Specimen typicum legit prope Tenino Junction, Pierce County, Wash., October 25, 1936, D. E. Stuntz n. *525,* in Herb. Univ. Wash. conservatum.

PILEUS 3.5 cm. broad, becoming expanded, nearly plane, broadly umbonate, the margin even, entire, plane, surface dry, rather densely silky-fibrillose becoming a little rimulose toward the margin, color uniformly tawny olive (R); context 6 mm. at center, elsewhere 3 mm., firm, pallid, odor faint, subraphanoid, not spermatic. LAMELLAE broadly and squarely adnate, very shallowly rounded at the stipe, bluntly rounded at the margin, asymmetric-ventricose, widest outward, not broad, about 3–4 × 13 mm.; edges eroded, white-fimbriate; of several lengths, subdistant; color Dresden brown (R). STIPE 6 cm. long, 7 mm. thick, equal, tapering slightly downward, the base not at all bulbous, solid, fibrous, surface satiny beneath a covering of more or less abundant superficial fibrils, color same as that of the pileus, but a little paler, and with a silvery sheen. SPORES 5–7 × 12–17–20.4 μ, elongate-amygdaliform to cylindric, usualy bluntly pointed or subconic apically; wall thick, tawny. PLEUROCYSTIDIA 12–17 × 60–73–82 μ, abundant, quite constant in size and shape, subcylindric, a little ventricose near the base, pedicel broad, poorly developed, apex obtuse, with a distinct cap-like thickening of the wall, very seldom muriculate; wall rather thin, yellow. CHEILOCYSTIDIA abundant, in clusters, projecting prominently, same general shape as the pleurocystidia, but more polymorphic, often broadly ventricose or saccate. STERILE CELLS abundant, clustered with the cystidia, large, clavate to capitate, basidia sometimes also intermingled. TRAMA OF LAMELLAE fairly compact, very heterogeneous, the cells varying greatly in shape from oval or vesiculose to narrowly cylindric; fusiform-ventricose, cylindric-inflated, sinuous, etc., also varying greatly in size, but predominantly large. Lactifers not seen.

Solitary on moss and conifer needles under Douglas fir, near Tenino Junction, Pierce County, October 25, 1936 (*525,* type).

This species is well characterized by the uniform brownish ochra-



FIGS. 18-26. Species of *Inocybe*.

ceous color of pileus and stipe, the broadly adnate, dark olivaceous brown lamellae, the long cylindrical spores with a subconic apex, and the cystidia with their peculiar cap-like thickening at the apex. The only really closely related species seem to be *Inocybe Poujoli* Heim and *I. fulvida* Bres. The former differs in its much smaller size, paler and more ochraceous color, spermatic odor, differently attached lamellae, and absence of pleurocystidia. The latter differs in its more fulvous pileus, sinuate-free lamellae which do not become olivaceous, marginate-bulbed stipe, somewhat shorter spores, and much broader pleurocystidia.

I take pleasure in dedicating this species to Dr. J. W. Hotson, whose active interest in the Agaricaceae of the West Coast has been a source of inspiration for many years.

10. INOCYBE LEPTOPHYLLA Atk. (FIGS. 21, 22)

PILEUS 3 cm. broad, obtusely campanulate, margin rounded, even, surface densely squarrose with small, hispid, erect, pointed, tuft-like scales, very crowded at the center, more appressed toward the margin, which is roughly lacerate-tomentose; color very dark brown, almost black at the center, auburn (R) at the margin; context thick at the center, firm, hygrophanous, pale smoke grey (R) when moist, odor faint, fungoid. LAMELLAE adnate, rounded at the stipe, tapering toward the margin, ventricose, edges convex, finely pallid-fimbriate, broad, about 5 × 13 mm., thin, close, color between snuff brown (R) and Verona brown (R). STIPE 4 cm. long, 5 mm. thick, cylindrical, equal, base not bulbous, solid, fibrous; surface tomentose-hairy below, apex scurfy, color Mikado brown (R) at the apex, shading into Argus brown (R) at the base. SPORES 7–8.5 × 9–11 μ, elliptical, covered with fifteen to twenty small round nodules, preserving the elliptical outline perfectly. PLEUROCYSTIDIA and CHEILOCYSTIDIA lacking. STERILE CELLS abundant, densely clustered along the edge, clavate or saccate, with a median or apical constriction (capitate), thin-walled, large, 11–13.5 × 35–45 μ. TRAMA OF LAMELLAE very compact, homogeneous, the cells practically all fusiform-ventricose, varying somewhat in size.

On rotten wood in dense coniferous forest, Cataract Creek, Carbon Glacier, Mt. Rainier, September 4, 1936 (*475*); same locality, on the ground along a path, August 12, 1937 (*611a*).

There is no difference in outward appearance between this species and *Inocybe lanuginosa* (Fr.) Quél., but the complete lack of pleurocystidia and the ellipsoid spores with 15–20 small regular nodules serve to distinguish *I. leptophylla*. Heim (**5**, p. 365) and Boursier and Kühner (**1**, p. 177) describe and illustrate as *I. Casimiri* Vel. a species to which my collections of *I. leptophylla* might very well be referred. They stress the importance of the ellipsoid spores with many small nodules as a distinguishing character of *I. Casimiri*. Evidently a study of the type of *I. leptophylla* is needed to determine whether or not it has the same type of spore. If the two species prove to be synonymous, *I. leptophylla* Atk. is the older name.

This is the first report of *I. leptophylla* from Washington.

FIG. 48. *Inocybe lucifuga* (Fr.) Quél., × 1.

11. INOCYBE LUCIFUGA (Fr.) Quél. (FIGS. 23, 24, 48)

PILEUS 3–4.5 cm. broad, campanulate, becoming expanded and shallowly campanulate, with a small mammiform umbo, margin lacerate, split, very irregular, surface appressed-fibrillose, remaining smooth at the center, becoming deeply rimose toward the margin, finally lacerate, excoriate, but never squamulose; color buff (309) t.–1 to bistre (328) t.–2 at the center, shading into chamois (325) t.–3, 4 at the margin; context 3–5 mm. at the center, hygrophanous, ocher below the cuticle, elsewhere white or pallid, odor faintly raphanoid, lacking in some specimens. LAMELLAE narrowly to broadly adnate, sometimes uncinate with a tooth, shallowly rounded at the stipe, bluntly so at the margin, ventricose, rather

broad, 6–8 × 16–17 mm., edges convex, white-fimbriate or not, turning brown in age; subdistant, regularly alternating in various lengths; color at first clear pale olivaceous, becoming near Isabella color (R), finally golden bronze green (298) t.–1. STIPE 2–5 cm. long, 4–6 mm. thick, cylindrical, equal or slightly incrassated downward, base not bulbous; solid, the context soft along the axis, compact but very fragile at the periphery, white or yellow-tinged, unchanging; surface glabrous, satiny, or with a few white fibrils below, apex white-pruinose; color white, flushed with Naples yellow (29) t.–1, especially toward the apex. SPORES 5–8 × 8–12.5(13) μ, mostly 7 × 10.5 μ, ovate-amygdaliform, the apex usually obtuse. PLEUROCYSTIDIA 14.5–25.5 × 50–70 μ, rather few, scattered over the surface of the lamellae, ventricose, with a slender pedicel and short neck, sometimes clavate, only slightly thick-walled apically. CHEILOCYSTIDIA abundant, scattered along the edge, usually wider than the pleurocystidia, sometimes surmounted by an amorphous globule. STERILE CELLS abundant, large, clavate, loosely clustered along the edge. TRAMA OF LAMELLAE rather loosely arranged, heterogeneous, the cells inflated-ventricose to fusiform-clavate or globular, most of them large.

Gregarious to subcespitose on needles and moss under *Abies* spp. and *Pinus contorta* Loud., along a stream, Chesapeake Saddle (elevation 6000 ft.), Chelan County, August 28, 1939 (*802*).

The uniformly ochraceous pileus, yellowish-olivaceous lamellae, white satiny stipe, and faint raphanoid odor are the distinguishing characteristics of this species. The flesh of both pileus and stipe is notably fragile, almost watery. My specimens are in excellent agreement with the description given by Heim (**5**, p. 201), and they also compare very well with a collection in the herbarium of the University of Michigan referred to *Inocybe lucifuga* by Kauffman. *I. lucifuga* seems to be a rare plant in North America; Kauffman did not include it in his monograph, and I can find no reference to it in any of the other American publications I have consulted.

12. INOCYBE OBSCURA (Fr.) Gill. (FIGS. 25, 26)

PILEUS 2–3 cm. broad, obtusely campanulate, becoming expanded and umbonate, surface at first silky-fibrillose, becoming slightly diffracted-squamulose at the center, rimulose toward the margin which is finally lacerate; color Sayal brown (R) at first,

becoming ochraceous tawny (R), sometimes darker, Vandyke brown (R) to sorghum brown (R); context 2 mm. at the center, odor spermatic. LAMELLAE adnate, sinuate, uncinate, obtusely rounded at the margin, rather broad, about 4 × 12 mm., very ventricose, edges convex, finely white- or brown-fimbriate, subdistant; color at first vinaceous buff (R) to light greyish vinaceous (R) or light vinaceous fawn (R), soon becoming Sayal brown (R) to snuff brown (R). STIPE 3.5–5.5 cm. long, 3.5–5 mm. thick, cylindrical, equal, the base slightly incrassated; surface satiny, with some superficial fibrils, the apex pruinose; color wood brown (R) below, becoming pallid, apex light russet-vinaceous (R) to russet-vinaceous (R), becoming in old specimens vinaceous-brown (R) or sorghum brown (R). SPORES 5–6 × 10.5–12 μ, amygdaliform, often pointed apically, and with a dorsal apicular depression. PLEUROCYSTIDIA 12–19 × 60–80 μ, abundant, ventricose-fusiform, usually slender, with more or less well defined pedicel, thick-walled apically. CHEILOCYSTIDIA numerous, not projecting prominently, in sparse clusters along the edge. STERILE CELLS abundant, clavate, large and conspicuous, often septate. TRAMA OF LAMELLAE loosely arranged, heterogeneous, the cells fusiform-inflated, variable in shape and size, with many slender hyphae present. Lactifers numerous in the subhymenium, forming an anastomosing network.

In conifer woods, Duval, July 2, 1935 (*330*); in grass under *Corylus californica,* (A. DC.) Rose, Seward Park, Seattle, May 6, 1936 (*428*); in grass under *Corylus californica,* (A. DC.) Rose, University of Washington campus, Seattle, May 7, 1937 (*428a, 429*).

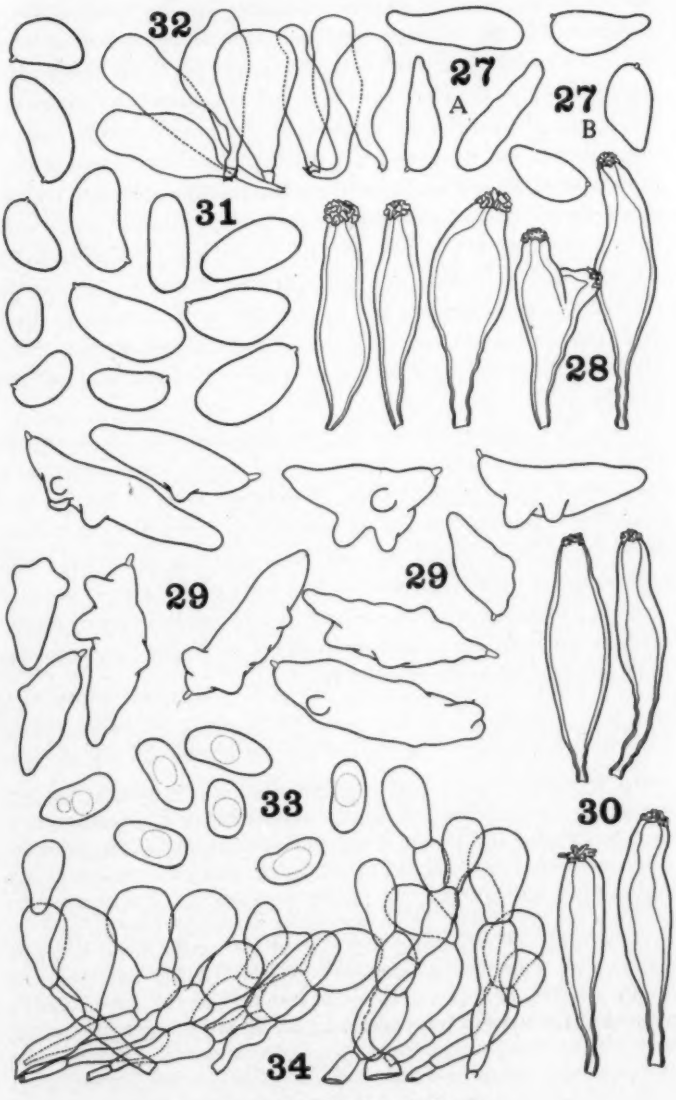
The plant described above answers best to the generalized description given by Heim (**5**, p. 253) of *Inocybe obscura,* (Fr.) Gill. except that the lamellae and apex of the stipe are vinaceous instead of some shade of violaceous. *I. obscura* var. *purpurea* Heim is very similar, but it is said to have the lamellae chamois at first. The question of what constitutes typical *Inocybe obscura* can hardly be said to have been settled by European mycologists, as anyone can see by consulting the publications of Lange, Heim, and others. I should like to make it clear that I do not consider my plant to be "typical" *I. obscura,* but merely a form whose color and other characters ally it more closely to this than to any other species.

13. INOCYBE OBSCURA (Fr.) Gill., Var. RUBENS Heim (FIGS. 27, 28)

PILEUS 1–4 cm. broad, usually 2–2.5 cm., campanulate, becoming expanded and finally plane, always umbonate, surface innately radially fibrillose, the umbo remaining glabrous, elsewhere silky-smooth or becoming very slightly rimulose, the margin becoming decorated with one or two ranks of tiny triangular fibrillose squamules, each tipped with white silky fibrils; color at first uniformly maroon (341) t.–2, 3, the umbo remaining so, elsewhere becoming burnt umber (304) t.–3, 4, paler when dry; context thin (3 mm. at the center), firm, hygrophanous, red-brown under the cuticle, elsewhere greyish, drying pallid, a little rose-tinged, unchanging; odor rather faint, but clearly spermatic. LAMELLAE narrowly adnate, shallowly rounded at the stipe, bluntly rounded at the margin, ventricose, moderately broad, 3 × 9 mm. to 5 × 12 mm., edges convex, even, not notably white-fimbriate; only moderately close, rather thick, sometimes intervenose; color smoke gray (363) t.–1, becoming more or less snuff brown (303) t.–1, 2. STIPE 2–5.5 cm. long, 2–6 mm. thick, cylindrical, equal, the base usually not bulbous but occasionally with a small rounded bulb; solid, the context fibrous, softer along the axis, yellowish or brownish below, rose colored or rosy vinaceous above, unchanging; surface glabrous, satiny, the apex white-pruinose; color pale pink (135) t.–4 or yellowish salmon (65) t.–1–4 or salmon flesh (138) t.–4, becoming tinged brown below. SPORES 4–6.5 × 9–16 μ, most commonly 5.5–6.5 × 9.8–11.5 μ, quite variable in size and shape, sometimes markedly apically constricted and prolonged. PLEUROCYSTIDIA (11)12–26.5(39) × 53–85(92) μ, abundant, fusiform-ventricose above a pedicel of variable length and thickness, usually lacking a well-defined neck, thick-walled. CHEILOCYSTIDIA numerous, projecting prominently, same size and shape as the pleurocystidia. STERILE CELLS abundant, long and conspicuous, clavate, densely crowded in a broad zone along the edge, with basidia sometimes intermingled. TRAMA OF LAMELLAE compact, the cells rather variable in size, fairly uniform in shape, fusiform, with many narrow cylindrical ones present.

Subcespitose to gregarious in moss on rotten wood or on the ground, beside a stream in woods of *Abies* spp. and *Pinus contorta* Loud., Chesapeake Saddle (elevation 6000 ft.), Chelan County, August 28, 1939 (*801*).

Apparently this variety of *I. obscura* (Fr.) Gill. had not been collected since Heim described it in 1931. My specimens conform



FIGS. 27–34. Species of *Inocybe*.

best to "forme b" of the two forms included in the variety (**5**, pp. 260–263). Their distinguishing macroscopic characters are the maroon pileus with tiny but conspicuous and persistent white marginal squamules, the incarnate stipe, and gray lamellae. Heim describes the pileus color as "brun-noir" or "brun purpurin" rather than maroon, and the lamellae as pallid ("blanchâtre") rather than gray at first, but because color is such a variable character in Inocybes, these discrepancies seem to me to be of minor importance. In one specimen of my collection the spores are predominantly of the long, narrow, distally tapered type illustrated in fig. 27a; in the remaining specimens they are shorter and more normal in shape (fig. 27b), with only an occasional elongated one among them. Heim mentions the same variation in spore size and shape (**5**, p. 263, fig. 169).

There is a certain amount of confusion and lack of agreement among mycologists concerning the several species and forms closely related to *I. obscura* (Fr.) Gill. It does not seem to me that this confusion is any the less for the inclusion of forms like var. *rubens* Heim which entirely lack the chief distinguishing character of the *obscura* group; namely, a violet or lilac color of the stipe or lamellae or both. Whether or not to exclude such forms, however, is a matter best left until the *I. obscura* complex in North American has been investigated more thoroughly.

14. INOCYBE RENNYI Berk. & Br. (FIGS. 29, 30)

PILEUS 1.5–4 cm. broad, hemispherical or campanulate, becoming obtuse or broadly campanulate, umbonate or not, surface dry, densely strigose-fibrillose to merely silky, becoming diffracted-scaly with numerous erect, pointed squarrae, the margin rimose and lacerate; color dark brown, the center raw umber (R) or mummy brown (R) or bistre (R), elsewhere Brussels brown (R) to Prout's brown (R); context 2–3 mm. at the center, firm, white or pallid, odor faint, mildly fungoid. LAMELLAE adnexed and deeply sinuate, or adnate, abruptly rounded at the stipe, bluntly pointed at the margin, ventricose, rather broad, 4 × 10 mm., edges very convex, finely white-fimbriate; close, of several lengths; color at first white, becoming cream buff (R), finally snuff brown (303) t.–2. STIPE 2–4 cm. long, 4–7 mm. thick, equal, cylindrical, base not bulbous, solid, the context white, unchanging; surface lanugi-

nose like that of the pileus but less densely so, and not scaly, apex densely white-pruinose; color avellaneous (R) to wood brown (R) above, Verona brown (R) to warm sepia (R) below. SPORES 6–10 (11.5) × 11.5–22 μ, very polymorphic, greatly prolonged apically, elsewhere bearing a few very large, coarse nodules, with the apiculus mounted on a mammiform projection. PLEUROCYSTIDIA 10.5–19.5 × 60–80(95) μ, not very abundant, clavate, with a long, slender pedicel and little or no neck, wall laterally thickened. CHEILOCYSTIDIA numerous, not projecting prominently, smaller than the pleurocystidia. STERILE CELLS numerous, clavate, almost as large as the cheilocystidia, intermingled with basidia along the partially fertile edge. TRAMA OF LAMELLAE not very compact, the cells mostly large, inflated-cylindric or ventricose-inflated; lactifers fairly abundant, large, sinuous, unbranched.

Under Douglas fir, Fort Lewis, May 16, 1936 (*438*); in woods of *Abies* and *Pinus contorta* Loud., Mt. Constitution (elevation 2400 ft.), Orcas Island, August 13, 1937 (*610*).

No other species of *Inocybe* has the greatly elongated, coarsely and often grotesquely nodulose spores that characterize *I. Rennyi* Berk. & Br. They are formed from the smooth, amygdaliform immature spores by the extreme elongation of the apex, followed by the formation of a few large, coarse nodules on the main body of the spore. Some of the macroscopic characters of this species seem to be rather variable. Thus, the specimens of No. *438* had umbonate, silky pilei, adnate lamellae, and a strong odor, whereas those of No. *610* had obtuse pilei with the surface like that of *Inocybe lanuginosa* (Fr.) Quél., adnexed lamellae, and the odor none or very faint. The presence of scales on the pileus is not mentioned by Heim, Rea, or Massee, nor shown in Cooke's illustration (**4**, pl. 520).

So far as I am aware, this is the second report of *Inocybe Rennyi* from North America. A. H. Smith has illustrated the spores and cystidia of specimens collected in Massachusetts (**13**, p. 100).

15. INOCYBE SORORIA Kauff. (FIGS. 31, 32)

PILEUS 2.5–7 cm. broad, narrowly conic-campanulate, or mitrate, long remaining so, finally shallowly campanulate or plane, with a prominent mammiform umbo, margin persistently appen-

diculate with conspicuous patches of white silky veil, finally glabrescent, rimose or deeply excoriated; surface at first smooth, silky-shining, soon deeply and conspicuously rimose everywhere except the umbo; color Naples yellow (29) t.–1, 2 or creamy white (10) t.–2, 3, 4 or ivory yellow (R), tinged Colonial buff (R) in some, and with the umbo darker, Naples yellow (29) t.–3, 4 to almost fulvous; context thin, firm, white, unchanging, odor very strong, of "green corn," not at all spermatic, very persistent. LAMELLAE adnexed to narrowly adnate, rounded at both ends, shallowly ventricose, rather narrow, 3 × 20 mm., thin, crowded, color Isabella color (R) to buffy citrine (R) or bistre green (296) t.–3, becoming golden bronze green (298) t.–1, finally Dresden brown (R). STIPE 5–13 cm. long, 4–10 mm. thick, equal or tapering slightly upward, cylindrical, base incrassated, rather abrupt, or rounded-bulbous in some; solid or stuffed, becoming hollow in some, context fragile, white, usually spirally twisted, surface rather densely white silky-floccose, the fibrils aggregated in small irregular flocci; color white, becoming tinged with dingy yellow or straw color below. SPORES 5.8–8(8.8) × 11–15.5(17) μ, ovoid to subreniform, very variable in size and somewhat so in shape. PLEUROCYSTIDIA and CHEILOCYSTIDIA lacking. STERILE CELLS abundant and conspicuous, crowded in a broad band along the edge of the lamella, one-celled, saccate, or clavate to subcapitate, very variable in shape and size, 13–28(35) × 45.5–73.5(81.5) μ.

Under Douglas fir and *Larix* spp., Thunder Bridge Forest Camp, October 20, 1940 (*929*).

This species is closely related to *Inocybe fastigiata* (Fr.) Quél., from which it differs in its ivory or pale cream colored pileus and its strong, persistent, very characteristic odor of green corn. In the original description (**7**, p. 259), Kauffman describes the odor rather vaguely as "somewhat pungent or lacking," which may account for the reluctance of some European mycologists to accept *I. sororia* as a valid species. Heim considers it to be synonymous with *I. fastigiata* (**5**, p. 184, footnote), but I cannot agree with him. Both species occur rather frequently in the conifer forests of Washington, and the differences between them are constant. The strong green corn odor of *I. sororia* is especially characteristic, and easily distinguished from the typically spermatic odor of *I. fastigiata*.

16. INOCYBE SUBDECURRENS Ellis & Ev. (FIGS. 33, 34, 49)

PILEUS 2–3.5 cm. broad, campanulate, becoming expanded, obtuse, finally plane, with a rather prominent umbo, the margin persistently incurved, lobed and wavy, surface densely appressed-lanuginose, becoming irregularly lacerate but not rimose, persistently covered with white superficial fibrils which are irregularly aggregated, forming squamules toward the margin, color cinnamon buff (R), quite uniform except where the white fibrils make it somewhat paler; context thin, firm, pale ocher, unchanging, without odor. LAMELLAE squarely and broadly adnate, uncinate,

FIG. 49. *Inocybe subdecurrens* Ellis & Ev., × 1.

moderately broad, about 3.5 × 10 mm., hardly ventricose, close, many times inserted; edges plane, conspicuously white-fimbriate, color at first Isabella color (R), becoming Dresden brown (R) to Prout's brown (R). STIPE 3–4 cm. long, 4–5 mm. thick, equal cylindrical, base not at all bulbous; hollow, context ochraceous; surface fibrillose, the fibrils forming tiny aggregates, with remains of the ample white cortina persisting for a time at the apex; color pinkish buff (R) to cartridge buff (R). SPORES 4.5–5.5(6) × 8–10(11) μ, predominantly reniform or subreniform, some ovate-subcylindrical; apiculus lacking. PLEUROCYSTIDIA and CHEILOCYSTIDIA lacking. STERILE CELLS closely crowded in a broad band along the edge of the lamella, al-

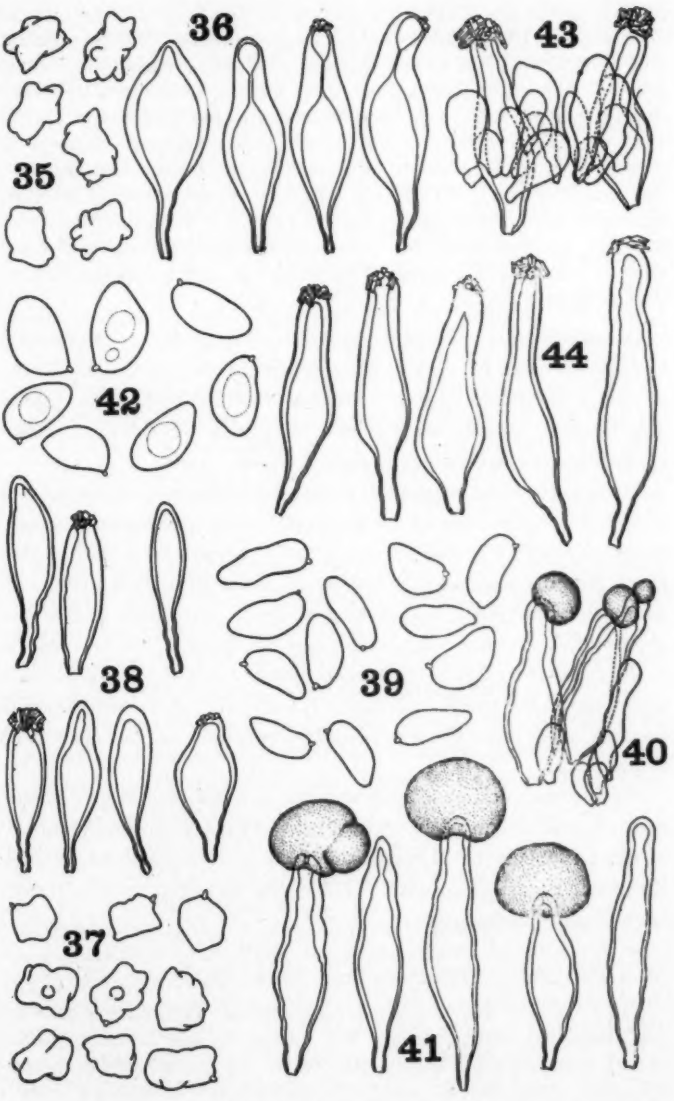
most always composed of 3 or 4 swollen cells, the terminal one of which is inflated-clavate or saccate, single-celled ones also present. TRAMA OF LAMELLAE very compact, homogeneous, the cells practically all inflated-cylindrical with a broad median constriction, varying somewhat in length but hardly at all in shape.

Gregarious on humus under *Alnus rubra* Bong. and *Acer macrophyllum* Pursh., Agate Pass, Bainbridge Island, July 18, 1937 (*604*).

Portions of the types of *Inocybe subdecurrens* E. & E. and *I. tomentosa* E. & E. (which are synonymous) deposited in the herbarium of the University of Michigan were examined, and my specimens were found to compare very well with them. Also, they fit the description given by Kauffman of *I. subdecurrens* (**7**, p. 257), except in having definitely olivaceous lamellae. In Heim's monograph they can be identified as *I. perbrevis* (Weinm.) Gill., but I hesitate to refer them to this species, which is figured and described by Cooke, Rea and Massee as being fulvous or tawny, and having the stipe very short. Heim's description does not apply too well to his figures (**5**, pl. V, fig. 2), which (at least the group in the middle, right) look very much like my plants. This is the first report of *I. subdecurrens* from Washington.

17. INOCYBE TRECHISPORA (Berk.) Karst., sensu Kauffman (FIGS. 35, 36)

PILEUS 4–4.5 cm. broad, obtusely campanulate to convex, becoming expanded, plane, with a broad shallow umbo, margin obtuse, surface very viscid when wet, almost slimy, drying satiny-shining, center unbroken, elsewhere more or less rimose; color tawny (R) to cinnamon brown (R) at the center, elsewhere Buckthorn brown (R) to Dresden brown (R); context thin, hygrophanous, firm, pallid or white; odor spermatic. LAMELLAE adnexed to nearly free, obtusely to shallowly rounded at the stipe, shallowly rounded at the margin, ventricose, rather broad, about 4 × 15 mm., edges convex, finely white-fimbriate and eroded; close, thin, of several lengths; color at first pale argillaceous, becoming drab (R), finally dark fawn (307) t.–1, 2 or snuff brown (R). STIPE 4–6 cm. long, 5–9 mm. thick, cylindric or flattened, equal above the small but definitely emarginate bulb, solid, rigid, fibrous; surface everywhere densely white-pruinose, satiny beneath the pruinosity, color ivory yellow (R) to cartridge buff (R), becoming



FIGS. 35–44. Species of *Inocybe*.

pinkish buff (R). SPORES 4.5–6(7) × 7.5–10(10.5) μ, angular-nodulose, the nodules coarse, large, rounded, 5–9 in number, PLEUROCYSTIDIA 13.5–22(25) × 45–65 μ, numerous, obese, inflated-ventricose, rounded apically, with a short neck and well defined pedicel, very thick-walled apically and laterally. CHEILOCYSTIDIA numerous, in dense, well separated clusters, or smaller groups mixed with sterile cells; shorter and broader than the pleurocystidia. STERILE CELLS numerous, small, clavate, clustered with the cheilocystidia. TRAMA OF LAMELLAE compact, homogeneous, the cells inflated-cylindric, varying somewhat in size and slenderness; lactifers few, large, sinuous, not or only seldom branched.

On needle litter under Douglas fir, Wells Point, Snohomish County, October 14, 1936 (*506*), November 15, 1936 (*552*).

This is one of the very few Inocybes with a really viscid pileus. The viscidity and the rigid, pallid, marginate-bulbed stipe distinguish it from other Inocybes with nodulose spores.

There seem to be at present at least two different interpretations of *Inocybe trechispora* (Berk.) Karst. That of Kauffman agrees essentially with Bresadola's concept of the species. On the other hand, Heim, Lange, and Rea describe a slender, pallid plant with white or ivory pileus, and lacking an emarginate bulb at the base of the stipe. Kühner has abandoned the name *I. trechispora* (**9**, p. 91), and describes as *I. mixtilis* Britz. a species which he says is the same as *I. trechispora* sensu Kauffman. It should be noted, however, that he does not describe the pileus of his species as being viscid.

My specimens check exactly with the description given by Kauffman (**7**, p. 234), and also with several collections in the herbarium of the University of Michigan referred to *I. trechispora* by both Kauffman and A. H. Smith. This is the first report of *I. trechispora* from Washington.

18. INOCYBE UMBRINA Bres. (FIGS. 37, 38)

PILEUS 2.5–4 cm. broad, campanulate, becoming expanded and furnished with a broad, low umbo, surface lubricous when moist, soon drying silky-smooth, center glabrous, elsewhere conspicuously long-rimose, color raw umber (R) to mummy brown (R) at the center, elsewhere cinnamon brown (R) to Prout's brown (R) or Dresden brown (R); context 5 mm. at the center,

elsewhere thin, hygrophanous, pallid or ochraceous, odor none or faintly raphanoid. LAMELLAE adnate, uncinate, emarginate, seceding at length, broad, 5 × 15 mm., ventricose, edges convex, finely pallid-fimbriate; close and thin, color snuff brown (R), Saccardo's umber (R), tawny olive (R), Sudan brown (R) or Brussels brown (R). STIPE 5–6 cm. long, 4–5 mm. thick, cylindrical, equal or tapering slightly upward, the base rounded-bulbous, solid or hollow, the context fragile; surface satiny, with a few superficial fibrils, the base white-myceloid, apex white-pruinose; color at first Mikado brown (R) to onion-skin pink (R), becoming Verona brown (R) to Sayal brown (R), darker at the base. SPORES 4.5–6.5 × 6–8(9) μ, varying from merely angular to coarsely nodulose, with 5 to 8 low, obtuse nodules. PLEUROCYSTIDIA 10–17(21) × 36–50(60, 75) μ, fusiform-clavate to clavate above a slender pedicel, thick-walled apically. CHEILOCYSTIDIA not very numerous, not projecting prominently, grouped in the clusters of sterile cells. STERILE CELLS numerous, cylindric to clavate or saccate, densely clustered, often mingled with basidia. TRAMA OF LAMELLAE homogeneous, compact, the cells mostly rather short, inflated-cylindric or ventricose; lactifers few, thread-like, small.

Along paths under conifers, Wells Point, Snohomish County, January 25, 1936 (*414*), November 15, 1936 (*548*); Carbon River road, near Fairfax, August 30, 1936 (*466*).

The umber brown, distinctly rimose pileus, brown stipe, and small angular to obscurely nodulose spores distinguish this species from the other members of the *umbrina* group. My specimens agree very well with the descriptions of *Inocybe umbrina* by Heim, Lange, Bresadola and Kauffman; they constitute the first record of this species from Washington.

19. INOCYBE VISCIDULA Heim (FIGS. 39–41)

PILEUS up to 3 cm. broad, convex-campanulate, becoming expanded, finally shallowly convex, not umbonate, surface viscid when wet, composed of agglutinated fibrils which are aggregated at the center, rimose toward the margin, which is decorated with white patches of cortina; color raw Sienna (R) at the center, elsewhere near Isabella color (R) but paler; context 3 mm. at the center, hygrophanous, translucent, gray, firm, odor faint, subraphanoid. LAMELLAE adnexed to narrowly adnate, somewhat sinuate, shallowly rounded at the stipe, bluntly rounded at the margin,

broad, about 4 × 11 mm., ventricose, edges shallowly convex, finely eroded; color near Saccardo's umber (R) but paler. STIPE up to 4.5 cm. long, 7 mm. thick, cylindrical, equal, the base with a very slight subemarginate bulb, solid, firm, the context white, unchanging, surface satiny, shining, longitudinally grammate, with superficial white fibrils, more abundant at the base where they form conspicuous white scales; apex white-pruinose; color pure white. SPORES 4–5 × 8–11 μ, smooth, often with a median or basal dorsal depression, sometimes rather pointed apically. PLEUROCYSTIDIA 10–17(19.5) × 55–80 μ, ventricose or fusiform or almost cylindrical, thick-walled apically, almost always surmounted by a large round globule of amorphous substance. CHEILOCYSTIDIA identical with the pleurocystidia, abundant, in dense clusters along the edge. STERILE CELLS lacking, edge of lamella fertile, made up of normal hymenial elements and cystidia. TRAMA OF LAMELLAE very compact, homogeneous, of small cylindrical or slightly cylindric-inflated cells. No lactifers seen.

In needle duff under Douglas fir, near Chase Lake, Snohomish County, October 3, 1936 (*502*).

The globular or reniform amorphous masses that surmount each cystidium are very distinctive. As illustrated in this paper they may appear somewhat larger than normal, due to the material having been revived by dilute potassium hydroxide. My plants differ from the description of *Inocybe viscidula* given by Heim (**5**, p. 132) in being somewhat larger, in having the stipe pure white, the pileus not acutely umbonate, and the spores narrower. The very striking cystidia make me inclined to overlook these discrepancies in referring my collection to Heim's species. The macroscopic characters of *I. viscidula* may be more variable than the original description indicates, and in any event, no other species of *Inocybe* has been described with the same kind of cystidia.

The present collection is the first record of *Inocybe viscidula* from North America, or from any other locality, as far as I can determine, since it was first found by Heim in 1927.

20. **Inocybe volvata**, sp. nov. (FIGS. 42–44, 50)

Pileus 2–2.5 cm. latus, campanulatus demum plano-expansus, umbonatus, siccus, glaber, sericeus, castaneus vel badius; caro tenuis, pallide grisea, immutabilis; odor fortis, spermaticus; lamellae adnexae, ventricosae, 3 mm. latae, subdistantes, ex albis sordide brunneae; stipes 2.5–4 cm. longus, 2–5 mm. crassus, aequalis, basis leviter bulbosus vel non, membrana alba volvae

valde simili praeditus, mox cavus, glaber, incarnatus, apice albo-pruinatus; sporae 5–7 × 7–10.5 μ, leves, amygdaliformes; pleurocystidia et cheilocystidia 12–18 × 62–90 μ, ventricosa, pedicellata. Specimen typicum legit prope Chase Lake, Snohomish County, Wash., D. E. Stuntz n. *400*, pars in Herb. Univ. Wash., pars in Herb. Univ. Mich., conservatum.

PILEUS 2–2.5 cm. broad, campanulate, becoming expanded and finally plane, but remaining always umbonate; surface even, smooth, innately radially silky, at most only slightly rimulose at the margin, which becomes split, and is persistently decked with white submembranous patches; color auburn (R) to Vandyke brown (R) or warm sepia (R), context thin, hygrophanous, pale grayish honey color, odor strong, spermatic. LAMELLAE adnexed, sometimes almost free, subdistant; ventricose, moderately broad, about 3 × 10 mm., edges convex, finely white-fimbriate, color at first white or pallid, becoming tawny olive (R) to snuff

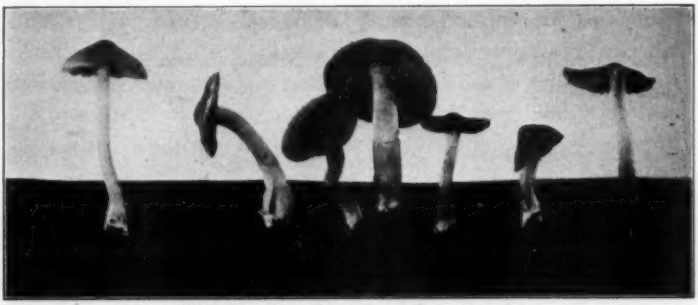


FIG. 50. *Inocybe volvata* Stuntz, × 1.

brown (R). STIPE 2.5–4 cm. long, 2–5 mm. thick, equal, cylindrical or slightly flattened in some, base slightly rounded-bulbous or not, furnished with a short, peronate, white membranous sheath, forming a volva-like structure, the upper margin of which may roll back, or be appressed to the stipe; solid, becoming hollow in age, the context incarnate, unchanging, surface satiny, glabrous, the apex white-pruinose; color pinkish buff (R) to light pinkish cinnamon (R). SPORES 5–7 × 7–10.5(11.5) μ, amygdaliform, with ventral or dorsal apical depression or both. PLEUROCYSTIDIA 12.5–18(19.5) × 62–90 μ, numerous, fusiform-ventricose above a slender pedicel, the neck more or less well developed; thin-walled to moderately thick-walled. CHEILOCYSTIDIA numerous, usually shorter and broader than the pleurocystidia. STERILE CELLS abundant, conspicuous, broadly clavate, in dense clusters along the edge. TRAMA OF LAMELLAE rather

loosely woven, very heterogeneous, predominantly of medium sized fusiform-inflated cells, varying much in shape and size, from vesiculose to cylindrical, with an extraordinary number of slender hyphae present; hyphae intertwining somewhat, flexuous or sinuous. No lactifers seen.

Along a road under Douglas fir and hemlock, near Chase Lake, Snohomish County, November 30, 1935 (*400*-type).

In very young sporocarps there is a white membranous veil which is attached to the pileus margin and sheathes the base of the stipe. When this ruptures, it does so near the pileus margin, on which it leaves remnants in the form of white patches, and forms at the base of the stipe a volva-like sheath. In half the specimens of the type collection the margin of this sheath had rolled back, forming a structure that looked not unlike the volva of *Amanita pantherina* Fr.; in the remainder of the specimens it was evident, but remained appressed to the stipe. Although it is not unusual for the remains of a copious cortina to form a more or less evanescent volva-like prolongation of the edge of a marginate bulb, the presence of a definitely membranous basal sheath is unusual in *Inocybe*.

In addition to the sheath, the distinguishing characters of *Inocybe volvata* are its dark red-brown smooth pileus, incarnate stipe which becomes hollow, and long narrow cystidia. Disregarding the sheath, it bears a superficial resemblance to *Inocybe brunnea* Quél. sensu Heim, which, however, differs in the larger spores and rubescent context. It also reminds one of some of the forms with incarnate stipe included by Heim in his *Stirpe obscura*. None of the species in Kauffman's monograph (7) seems closely related to it.

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EXPLANATION OF FIGURES

FIGS. 1–9. 1, pleurocystidia of *Inocybe albodisca*. 2, eight spores of *I. albodisca*. 3, pleurocystidia of *I. castanea*. 4, five spores of *I. castanea*. 5, portion of a cross section of the edge of a lamella of *I. chelanensis*, showing deeply embedded cheilocystidia, mingled with fertile basidia. 6, pleurocystidia of *I. chelanensis*. 7, nine spores of *I. chelanensis*. 8, pleurocystidia of *I. cicatricata*. 9, ten spores of *I. cicatricata*.

FIGS. 10–17. 10, eight spores of *Inocybe decipientoides*. 11, pleurocystidia of *I. decipientoides*. 12, spores of *I. dulcamara*. 13, sterile cells of *I. dulcamara*. 14, six spores of *I. fulvella*. 15, five pleurocystidia of *I. fulvella*. 16, spores of *I. geophylla* var. *lateritia*. 17, five pleurocystidia of *I. geophylla* var. *lateritia*.

FIGS. 18–26. 18, spores of *Inocybe Hotsoniana*. 19, five pleurocystidia of *I. Hotsoniana*. 20, sterile cells and a cheilocystidium of *I. Hotsoniana*. 21, spores of *I. leptophylla*. 22, sterile cells of *I. leptophylla*. 23, spores of *I. lucifuga*. 24, four pleurocystidia of *I. lucifuga*. 25, spores of *I. obscura*. 26, pleurocystidia of *I. obscura*.

FIGS. 27–34. 27a, three long, distally tapered spores of *Inocybe obscura* var. *rubens*. 27b, three of the normal type of spore of *I. obscura* var. *rubens*. 28, five pleurocystidia of *I. obscura* var. *rubens*. 29, eleven spores of *I. Rennyi*. 30, four pleurocystidia of *I. Rennyi*. 31, twelve spores of *I. sororia*. 32, sterile cells of *I. sororia*. 33, seven spores of *I. subdecurrens*. 34, sterile cells of *I. subdecurrens*.

FIGS. 35–44. 35, six spores of *Inocybe trechispora*. 36, four pleurocystidia of *I. trechispora*. 37, spores of *I. umbrina*. 38, seven pleurocystidia of *I. umbrina*. 39, spores of *I. viscidula*. 40, cheilocystidia and sterile cells of *I. viscidula*. 41, five pleurocystidia of *I. viscidula*. 42, seven spores of *I. volvata*. 43, two cheilocystidia and several sterile cells of *I. volvata*. 44, five pleurocystidia of *I. volvata*.

BRAZILIAN CHYTRIDS. X. NEW SPECIES WITH SUNKEN OPERCULA

JOHN S. KARLING[1]

(WITH 56 FIGURES)

In a previous publication concerning a *Diplophlyctis*-like endooperculate chytrid from Amazonas, Brazil, the author (9) reported the isolation and culture of four additional species with sunken opercula. These species are largely extramatrical in relation to their substrata and possess large sporangia with one to several exit papillae or tubes, and coarse richly-branched rhizoids which usually arise from several points on the periphery of the sporangium. In these characteristics they are similar to species of *Rhizophlyctis,* but the presence of operculate sporangia excludes them from this genus as it is now interpreted by most chytridologists. At the time of their discovery no operculate genus of this type was known in which they could be placed, so the author established a new genus for them. However, before the description of this genus and species had gone to press, Miss Johanson (6) published a paper in which she showed that a very similar species, *Rhizophlyctis rosea,* is likewise endoöperculate. Therefore, she created a new genus for chytrids of this type with sunken opercula and named it after the author, which eliminated the necessity of the genus proposed by him. Accordingly, the operculate species from Brazil are here transferred to this genus, but in so doing the author is placed in the embarrassing position of adding new species to a genus which bears his name.

The first of these Brazilian species to be described is characterized by spherical zoöspores which contain from ten to more than forty minute hyaline granules, coarse irregular rhizoids, exo- and endoöperculate sporangia, and brown resting spores. The lack of pigment and the presence of numerous minute hyaline granules in the protoplasm impart to the zoöspores and mature zoösporangia a

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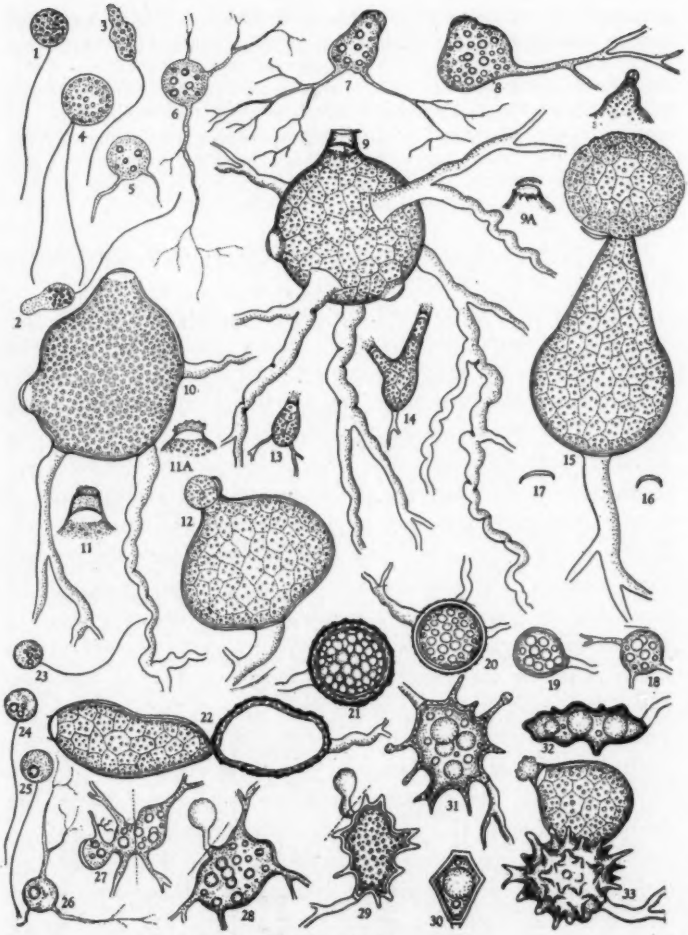


FIGS. 1–22. *Karlingia granulata.*
23–33. *K. spinosa.*

distinctive grayish-granular appearance quite unlike that of *Karlingia rosea*. Because of this characteristic difference it is diagnosed as a new species and named *K. granulata.*

Karlingia granulata sp. nov. (FIGS. 1–22)

Sporangiis hyalinis, laevibus, sphaericis, 8–240 μ, pyriformibus, 6–50 × 10–120 μ, ovalibus, 8–60 × 10–90 μ, elongatis vel irregularibus; 1–5 papillis

exeuntibus vel tubulis, 5–8 × 7–110 μ. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametro attingentibus 12 μ, maxime ramosis et extensis. Operculo hyalino, tenui, apiculato vel submerso in papillis exeuntibus vel tubulis, vadosis, figura ad modum patellae vel crateris usque ad 15 μ diametro. Zoosporis hyalinis sphaericis, 5.5–6.5 μ, plurimis granulis minutis praestantibus, flagello 35–40 μ longo. Sporis perdurantibus laevibus vel rugosis, fuscis, pariete crasso praeditis, 2–3.5 μ diam., sphaericis, 6–25 μ, ovalibus, 10–20 × 13–25 μ; germinatione a prosporangio.

Saprophytic in decaying vegetable debris in moist soil samples, San Carlos, Matto Grosso, Brazil.

The developmental cycle of this species is shown in figures 1 to 22. The zoöspores are spherical during the active swimming phase (FIG. 1), but they may come to rest and creep about occasionally as amoebae with their long flagellum trailing behind (FIGS. 2, 3). Quite often unequal or incomplete cleavage occurs in the sporangia with the result that large multiflagellate zoöspores are produced (FIG. 4). In some sporangia zoöspores varying from 10 to 16 μ in diameter with four to eight flagella have been observed. However, the larger ones usually fail to escape with the normal-sized zoöspores and may continue to swarm in the sporangia for more than an hour. After a motile period of twenty to seventy minutes, the zoöspores come to rest and form one to four germ tubes which penetrate the substratum or radiate in several directions (FIGS. 5, 6) and develop into the main axes of the rhizoidal system. In cases in which only one germ tube is formed, the resulting thalli have monoaxial rhizoidal systems as are shown in figs. 8, 12, 14, and 15. The mature rhizoids are usually very coarse with the main axes up to 12 μ in diameter, richly branched, and may extend for almost a millimeter in distance in large thalli. They are characteristically constricted and irregular in outline with conspicuous trabeculae extending into the lumen (FIG. 9). As they increase in age, the walls thicken and become brown in color.

While the germ tubes are branching and developing into rhizoids, the body of the spore enlarges and eventually becomes the sporangium, as in species of *Rhizophlyctis*. Often, one side of the spore becomes thick walled with the result that the sporangium may have a thickened region or cap on one side (FIGS. 7, 8). In rare instances only part of the zoöspore enlarges into a sporangium while

the other part remains unchanged as a hemispherical appendage at one side. In such cases it looks as if the sporangium had budded out from the zoöspore body. The mature sporangia of *K. granulata* vary markedly in size and shape, as is shown in figs. 9, 10, 12, 13, 14, and 15. As the substratum or culture medium becomes depleted in available food, the thalli and sporangia become increasingly smaller, so that sporangia with only four (FIG. 13) to sixteen zoöspores may often be found. As was noted before, the protoplasm of mature sporangia and zoöspores includes numerous minute granules which give it a grayish granular appearance quite unlike the rosy pink or light orange to golden color of *K. rosea.*

This species is normally monocentric; but in exceptional and rare cases it may become polycentric. Among the thousands of thalli studied, five were polycentric. Three of these had large primary sporangia and a small secondary one, as in *Phlyctorhiza variabilis* Karling (**1946**), whereas the other two had secondary and tertiary sporangia.

One of the distinguishing characteristics of *K. granulata* is the occurrence of exo- and endoöpercula. Fig. 9 shows a large spherical sporangium with three exit papillae, two of which are capped by exoöpercula. The third papilla, however, contains a small amount of opaque material, under which lies an endoöperculum. That this figure does not represent a case of sporangial proliferation is evident from the fact that all stages in the formation of such opercula can be readily followed in living material. In other sporangia the tip of the papilla or tube deliquesces (FIGS. 11, 11A) as the protoplasm retracts slightly, and eventually an operculum is formed a short distance down in the tube, as is shown in figs. 13 and 14. The development of the operculum in such cases is very similar to that described for *Nowakowskiella granulata, N. macrospora, Nephrochytrium amazonensis, Karlingia rosea* and *Catenomyces persicinus* by the author (**8, 10**), Miss Johanson (**6**) and Miss Hanson (**1**), respectively, with the exception that no large, sharply-defined plug of hyaline material is formed at the tip. In a few sporangia the exoöperculum had separated from the rest of the papilla along a jagged line and was pushed off by an endooperculum which formed underneath (FIG. 9A). In such cases two opercula were developed in succession by one exit papilla.

The majority of sporangia so far observed were exoöperculate, and as the zoöspores emerged, the opercula were pushed up and folded back (FIGS. 12, 15) or lifted off directly. Nevertheless, *K. granulata* shows a marked variation from exo- to endoöperculate sporangia. The opercula are usually shallow and saucer-shaped as shown in figs. 16 and 17. So far, no retracted opercula within the empty sporangia, like those found by Miss Johanson in *K. rosea,* have been observed in this species.

Another notable difference is the behavior of the emerging zoospores. In *K. rosea* the first zoöspores form a small globular mass at the exit orifice but soon disperse and swim away, while the remaining ones in the sporangia swarm rapidly and eventually emerge. In *K. granulata,* on the other hand, the initial behavior of the zoöspores is like that of *Endochytrium, Septochytrium, Nephrochytrium,* and other similar species. The zoöspores emerge slowly (FIG. 12) and form a large mass at the exit orifice where they remain inactive for longer periods of time. The peripheral spores then gradually become active, disengage themselves and swim away, and within a few minutes the whole mass is dispersed.

Resting spores developed readily in laboratory cultures of this species, and occurred in such profusion that substrata like bits of cellophane, onion skin, and corn leaves became dark brown in color. The young spores soon become distinguishable from incipient sporangia by an accumulation of refractive globules in the cytoplasm (FIG. 18) and a thickening of the wall (FIG. 19). As they mature, the outer layer of the wall turns brown and often becomes slightly rough (FIGS. 20, 21). At the same time, the globules increase in number and become closely packed together, as shown in fig. 21. The spores may remain in this condition for two to three months after which they germinate under normal laboratory conditions. In this process a pore is formed in the wall through which the content grows out and develops into a thin-walled hyaline zoösporangium (FIG. 22). Such sporangia may be exo- or endoöperculate like the primary ones described above.

Karlingia spinosa sp. nov. (FIGS. 23–43)

Sporangiis laevibus, sphaericis, 5–400 μ, pyriformibus, 5–160 × 10–200 μ, ovalibus, 4–70 × 7–100 μ, elongatis, angularibus vel irregularibus; 1–18 papil-

lis exeuntibus vel tubulis, 4–10 μ longitudine × 3–7 μ diametro ab infimo, quarum fines implantae sunt obturamento hyalino glutinoso, quod usque ad 5–12 μ supra verticem terminari potest. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis, diametrum, attingentibus 10 μ, maxime ramosis et extensis. Operculo hyalino, tenui, submerso in papillis exeuntibus vel tubulis, vadosis figura ad modum patellae vel crateris usque ad 8 μ diam.; expulsis et oblatis, zoosporis emergentibus, aliquibus—operculis accessoriis desorptis in sporangia, zoosporis emergentibus et pressione interna relaxante. Zoosporis sphaericis vel minime ovalibus, 3.3–4.4 μ diam. cum 1–5 granulis minutis praestantibus; maturis initialibus emergentibus saepe globuloso cumulo formato, orifice tubuli exeuntis postea enantibus; flagello 28–32 μ longitudine. Sporis perdurantibus sphaericis, 6–22 μ, ovalibus, 8–12 × 10–15 μ, fusiformibus, elongatis, clavatis, minime rectangularibus 5–8 × 12–17 μ, stellatis vel irregularibus, pariete crasso praeditis, 2–2.5 μ, spinosis vel verrucosis, rebus content's granulosis et globulosis refractivis, colore luteo-fulvosum; germinatione a prosporangio.

Saprophytic in decaying vegetable debris in moist soil samples from San Carlos, Matto Grosso, Brazil.

This species was found in the same culture with *K. granulata* and *K. rosea* and gets its name from the spiny and verrucose character of the resting spore wall. The type of development, growth, structure, and appearance of the thalli as well as the behavior of the zoöspores are so similar to those of *K. rosea* described by Miss Ward (**12**) and Miss Johanson (**6**) that it is not necessary to describe them here in detail. However, several differences have been observed, and the present description will be limited to them.

The zoöspores are smaller than those of *K. granulata* but approximately the same size as those of *K. rosea*. However, instead of containing a large number of minute granules, as in these two species, they include from one to six golden brown refringent globules (FIGS. 23–26). The smaller globules often coalesce so that by the time the zoöspores come to rest and germinate, only one globule is present (FIGS. 25, 26). However, this characteristic is not always reliable enough for diagnostic purposes. The number and size of the globules appears to be dependent to some degree on the rapidity with which the sporangia mature and shed their zoöspores. In old sporangia which failed to dehisce, the spore initials contained only one globule. The zoöspores usually germinate extramatrically and develop into thalli in the same manner as described for *K. granulata* and *K. rosea*, but occasionally the branched

germ tube swells at the point where it enters the substratum and develops into an irregular incipient sporangium instead of becoming the main rhizoidal axis. In such instances the sporangia become partly intra- and extramatrical with the zoöspore and one or more small rhizoids attached as an appendage (FIG. 27). In very rare and exceptional cases the sporangium and rhizoids may be formed entirely within the substratum. In the development of such thalli the incipient sporangium begins as a swelling in the intramatrical portion of the branched germ tube. As it enlarges, the incipient rhizoids are spread apart and become more or less radially arranged on the periphery of the sporangium (FIG. 28). The empty zoöspore case and a portion of the penetration tube, in the meantime, remain attached on the outside. Such thalli are rare as far as present observations go but their occurrence shows that the type of development of a species is not absolutely fixed and unvarying. Each species apparently has a normal type of development from which it may vary in different degrees.

Another but less reliable difference between *K. rosea* and *K. spinosa* is the golden red color of the protoplasm of the latter species in contrast to the rosy pink of *K. rosea*. However, as has been noted by most students of the latter species, the color varies from a faintly-perceptible pink in small sporangia to almost red in the larger ones, and similar but not so extensive variations have been found in *K. spinosa*. Therefore, this character cannot always be regarded as distinctive for species which are otherwise very similar. Another variation observed in *K. spinosa* may be noted here. In old cultures several of the exit tubes became thick-walled at the tip instead of deliquescing, and with further elongation they often became curved, so that the mature sporangium bore from three to eight slightly bent, horn-like structures on its surface in addition to the coarse rhizoids. In such thalli the sporangial wall also became unusually thick and brown in color as the sporangia went into a dormant stage. It is not improbable that similar horned sporangia may possibly be found in *K. rosea* also.

In the more normal sporangia the tip of the exit tube deliquesces and forms a plug of hyaline material, while the operculum develops underneath. The subsequent behavior of the operculum and zoospores as they are discharged is so similar to that described by

Miss Johanson for *K. rosea* that it need not be repeated here. It will suffice to note that as the zoöspores are discharged from other exit tubes and the internal pressure is reduced, a few opercula are often sucked down into the sporangium. Furthermore, in old cultures cleavage is sometimes unequal so that large zoöspores are formed. In several sporangia giant multiflagellate zoöspores up to 20 μ in diameter were found which included a golden refractive globule 5 to 12 μ in diameter. Because of their large size, such spores were unable to escape and degenerated within the sporangium after a motile period of one-half to two hours.

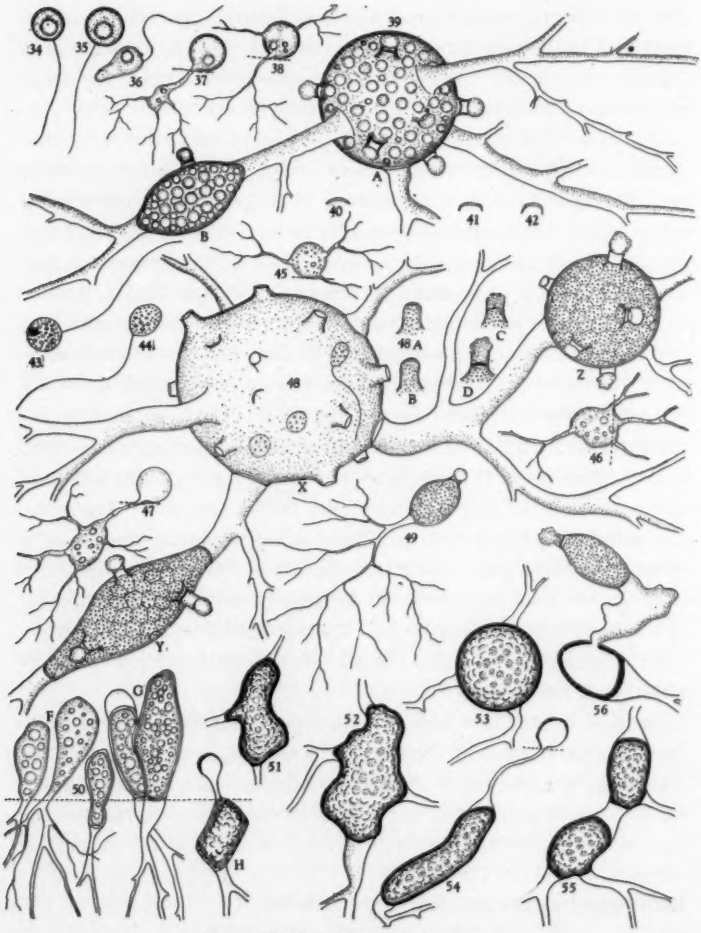
The most distinguishing feature of *K. spinosa* is the spiny and verrucose wall of the resting spores, which occur in abundance as the cultures become old. Like those of *K. granulata,* they develop in the same manner as the sporangia up to a certain stage. Later the wall begins to thicken, becomes warty or spiny and turns golden brown, while the protoplasm becomes coarsely granular and filled with numerous golden globules. The latter gradually coalesce to form several larger globules (FIGS. 30–32). In a few cases completely intramatrical resting spores were found with attached empty zoöspore cases and germ tubes (FIG. 29). These apparently developed in the same manner as the intramatrical sporangia described above. The abruptly tapering spines or pegs are usually solid and may sometimes be tipped by a definite knob (FIG. 31). They may also become slightly curved and bifurcate. Quite often they may be reduced to blunt pegs or warts (FIG. 32). After a rest period of from two to four months under laboratory conditions, the resting spores germinate in the same fashion described above for *K. granulata.* Fig. 33 shows a germinated spore in surface view with the attached zoösporangium.

In this connection it may be noted that *K. spinosa* has recently been isolated from soil collected near Sharon, Conn., U. S. A. The American specimens are similar in structure and development to those from Brazil. However, some of the spines on the resting spores were up to 12 μ in length.

Karlingia hyalina sp. nov. (FIGS. 34–42)

Sporangiis hyalinis, laevibus, sphaericis, 8–85 μ, ovalibus, 7–20 × 10–35 μ, pyriformibus, 10–30 × 20–55 μ, fusiformibus, angularibus, vel irregularibus;

1–7 papillas exeuntes vel tubulis habentibis, 7–20 μ longitudine × 3–6 μ diam. ad infimo, quarum fines implantae sunt obturamento hyalino glutinoso, quod usque 4–10 μ supra verticem terminari potest. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis, diametrum, attingentibus 12 μ, maxime ramosis et extensis. Operculo hyalino, tenui, submerso in papillis exeuntibus vel tubulis, vadosis figura ad modum patellae vel crateris usque ad 6 μ diam., expulsis



FIGS. 34–42. *Karlingia hyalina.*
43–56. *K. rosea.*

et ablatis, zoosporis emergentibus. Zoosporis sphaericis, 4–5.5 μ, cum uno globulo refractivis hyalinis, 2–2.5 μ diam.; flagello 30–36 μ longitudine. Sporis perdurantibus ignota.

Saprophytic in decaying vegetable debris in moist soil, San Carlos, Matto Grosso, Brazil.

The organization, structure, and development of this species are so similar to those of *K. spinosa* and *K. rosea* that only the distinguishing structural characteristics will be noted here. Unlike all other known species of this genus, the zoöspores contain one large hyaline, glistening refractive globule, as is shown in figs. 34 to 36. These globules impart a different and characteristic refringent appearance to the mature sporangia also (FIG. 39). As in the previously described species, the zoöspores usually germinate extramatrically with one to several germ tubes (FIG. 38) which develop into the main rhizoid axes, while the zoöspore body becomes the sporangium. In exceptional and rare cases, however, the sporangia and rhizoids may develop intramatrically from a swelling near the tip of a branched germ tube (FIG. 37). This species is usually monocentric, but like *K. granulata* it rarely forms polycentric thalli with a large primary (FIG. 39A) and smaller secondary sporangium (FIG. 39B). So far, resting spores have not been found, and our knowledge of the life cycle of *K. hyalina* is incomplete in this respect.

In connection with the three new species described above it may be noted that the type species, *K. rosea,* also is abundant and widely distributed in Brazil. So far it has been found in all soil samples collected in the Amazon Valley. Its life history and development are too well known to merit further detailed description, but mention is made of it here to confirm the observation of Miss Johanson on the operculate character of the sporangia, and the behavior of the endoöpercula as the zoöspores are discharged, as well as to emphasize some of the variations which occurred in the Brazilian material. Particularly noteworthy is that the thalli, in exceptional cases, may become polycentric as in *K. granulata* and *K. hyalina.* Up to the present time only ten polycentric specimens have been found among the many thousands studied. Fig. 48 shows one of these specimens with a large central primary sporangium at X and secondary sporangia at Y and Z. The monocentric thalli also vary

markedly in size. Thalli with spherical sporangia up to 450 μ in diameter have been observed. In contrast with these, minute sporangia (FIG. 49) which bear as few as four zoöspores often occur in the same substratum.

Another variation to be noted is that the thalli may sometimes develop partly intra- and extramatrically (FIG. 46) or completely intramatrically at the end of the penetration tube (FIG. 47) as in *K. spinosa* and *K. hyalina*. The latter type of development, however, appears to be very rare. When grass leaves, cellophane, and onion skin are used as substrata it is often difficult to determine whether the thalli are intra- or extramatrical, or partly so, particularly if the edges of the substrata are softened, disintegrating or covered with slime. Most investigators, however, have contended that *K. rosea* develops extramatrically with its zoösporangia arising directly from the zoöspore. The type of development and position of the thallus relative to its substratum can be readily determined if single cells are used as substrata. Individual cotton fibers are one-celled, tenuous, and usually smaller in diameter than the sporangia formed by *K. rosea*, so that if the latter are formed intramatrically the fibers become locally distended. Care should be taken to use only unprocessed fibers whose ends are sealed up and to avoid torn specimens so as to prevent entry of the zoöspores and their direct development intramatrically into zoösporangia. In cultures baited with carefully selected fibers, approximately 99 per cent of the sporangia were extramatrical and the remainder were intramatrical. In the latter class, a few empty zoöspore cases were found attached to the outside of the fibers and in contact with intramatrical thalli by a narrow penetration tube, as shown in fig. 47.

In this connection it should be noted that Haskins (**3**, **4**) also found numerous thalli of *Rhizophlyctis peterseni* which had developed from the germ tube instead of from the zoöspore. However, the chytrid which he figured is probably *K. rosea* instead of *R. peterseni*. The latter species is chitinophilic, and we have isolated and grown it in culture on bits of purified chitin and chitin agar. It has not grown on cellophane as described by Haskins, nor does it produce a large number of exit tubes with plugs of opaque material. For these reasons we believe that Haskin's species is *K.*

rosea, and in that event our discovery of intramatrical thalli which developed from the germ tube confirms his observations.[1] We have frequently observed this type of development also in *Asterophlyctis sarcoptoides,* another monocentric, eucarpic chytrid, when it was grown in pure culture on strips of chitin or chitin agar, which indicates that it may be fairly widespread among chytrids.

Resting spores developed abundantly in cultures from soil samples collected at San Carlos, Matto Grosso, Porto Velho, Amazonas, and Manaus, Amazonas. They usually occur in groups on the surface of corn leaves and onion skin and in such cases are often clavate in shape. On the other hand, spherical, angular, elongate, oval and irregular spores are not uncommon in this species. While most of them are extramatrical, partly or completely intramatrical ones may occur rarely (FIGS. 50H, 54). In the latter event the empty zoöspore case may remain attached on the outside. So far as is known, the resting spores develop like the sporangia in the early stages but soon become filled with refractive material (FIG. 50F), and thick walled. While these changes are taking place, the protoplasm frequently contracts so that the mature spore often fills only a portion of the expanded thallus (FIG. 50G). In maturation the wall of the spores turns golden brown, and the refractive globules disperse until the content is coarsely granular (FIGS. 51–55). Figure 55 shows a thallus with two resting spores which were probably formed by the constriction, separation into two parts, and encystment of the sporeplasma. In germinating, the resting spores function as prosporangia and give rise to thin-walled zoösporangia (FIG. 56) as in the previously described species. However, in a large number of spores the contents grew out into contorted and fantastically-shaped vesicles which often continued to grow and enlarge until the protoplasm was completely used up.

The observation that the thallus of *Karlingia* may sometimes develop intramatrically at the end of a penetration tube shows that the type of development of this genus is not absolutely fixed and unvarying. In the majority of thalli the zoöspore body develops directly into the sporangium, while the germ tubes become the main

[1] Haskins (Trans. Brit. Mycol. Soc. **29**: 138. 1946) has recently transferred this species to the genus Entophlyctis and named it *E. aurea.*

rhizoidal axis. The determining factor in this method of development apparently is the position of the nucleus. If it remains in the zoöspore, the latter becomes the center of development and organization and develops into a sporangium. Sometimes, however, the intramatrical tip of the germ tube gives rise to the sporangium and rhizoidal system. In such cases the nucleus apparently passes into the germ tube so that the center of development is transferred from the zoöspore to the penetration tube. Although there are no cytological data on *Karlingia* to prove this point at present, it has been demonstrated in *Endochytrium* and *Cladochytrium* by Hillegas (**5**) and the author (**7**), respectively, that the type of organization and development is closely associated with the localization and distribution of the nuclei in the thallus.

The discovery of occasional polycentric thalli in species which are predominantly monocentric indicates that this type of organization likewise is not absolutely fixed. The occurrence of reduced monocentric thalli in polycentric species is not uncommon, but the presence of polycentric specimens in monocentric species has been reported only for *Phlyctorhiza endogena* Hanson (**2**), *P. variabilis* Karling (**11**), and the species of *Karlingia* described above. Here also the transition from monocentric to polycentric thalli is quite probably dependent on the distribution and position of the nuclei. If one or several nuclei migrate out into the rhizoids of a monocentric species, become localized in a definite region, and divide, the rhizoid may enlarge locally and give rise to a secondary sporangium. This explanation is supported by the observation in *Cladochytrium replicatum* (**7**) that sporangia and resting spores develop only in regions of the rhizomycelium where the nuclei become localized and multiply.

SUMMARY

Three new chytrids, *Karlingia granulata, K. hyalina,* and *K. spinosa,* were isolated from soil samples collected in the Amazon Valley in Brazil and grown on various substrata which contain cellulose. They have the same type of development, organization, and structure as species of *Rhizophlyctis* but differ by the presence of exo- and endoöpercula in the sporangia. In *K. granulata* the

majority of opercula occur at the apices of exit papillae or tubes, but frequently the tips of the papillae deliquesce and the opercula are formed beneath. In the other two species, the tip of the exit tube always deliquesces and becomes filled with a plug of hyaline material, while the operculum develops underneath. *Karlingia granulata* is characterized by spherical zoöspores which contain numerous minute hyaline granules, and by smooth brown resting spores, whereas *K. spinosa* is distinguishable by spiny and verrucose resting spores and zoöspores with one to six golden globules. In *K. hyalina*, on the other hand, the zoöspores contain one large conspicuous hyaline refractive globule. In addition to these three species, *K. rosea* was found in all soil samples from Brazil. In all species except *K. spinosa* a few polycentric thalli were observed.

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EXPLANATION OF FIGURES

FIGS. 1–22, *Karlingia granulata*. FIGS. 23–33, *K. spinosa*. 1–3; spherical and amoeboid zoöspores containing numerous minute granules, × 1100. 4; large biflagellate zoöspore, × 1100. 5, 6; germination of zoöspores, × 1200. 7, 8; young thalli, × 1200. 9; mature spherical sporangium with three operculate exit papillae; rhizoids irregular and arising from several points on surface of sporangium, × 1400. 9A; primary operculum with jagged edge being pushed off by secondary operculum underneath, × 1500. 10; sporangium with two exoöperculate exit papillae, × 1400. 11; deliquescence of tip of exit papilla and the formation of an operculum beneath, × 1500. 11A; papilla with a small, low plug of opaque material, × 1500. 12; early stage of zoöspore discharge, × 1100. 13, 14; minute sporangia with endoöpercula, × 1200. 15; later stage of zoöspore discharge, × 1100. 16, 17; variations in size of opercula, × 1500. 18–21; stages in the development of resting spores, × 1100. 22; germination of resting spore, × 1100. 23–25; zoöspores containing one to six golden brown globules, × 1100. 26; extramatrical germination of zoöspore, × 1100. 27; young partly extra- and intramatrical thallus, × 1100. 28; young intramatrical thallus with attached zoöspore case and germ tube, × 1100. 29; young intramatrical spiny resting spore with attached zoöspore case and germ tube, × 1100. 30; diamond-shaped resting spore, × 1100. 31, 32; large spiny and elongate warty resting spores, × 1100. 33; surface view of spiny resting spore germinating, × 1100.

FIGS. 34–42, *Karlingia hyalina*. FIGS. 43–56, *K. rosea*. 34–36; spherical and amoeboid zoöspores with a large refringent globule, × 1100. 37; exceptional and rare intramatrical thallus developing at tip of germ tube, × 1100. 38; usual type of extramatrical thallus development, × 1100. 39; polycentric thallus with primary and secondary sporangia at A and B, × 1000. 40–42; variations in shape of operculum, × 1400. 43–44; spherical and oval zoöspores containing numerous minute granules, × 1100. 45; usual type of extramatrical thallus development, × 1100. 46; young partly intra- and extramatrical thallus, × 1100. 47; rare type of intramatrical thallus development, × 1100. 48; large polycentric thallus with primary sporangium at X and secondary sporangia at Y and Z, × 900. 48 A, B, C, D; successive stages of deliquescence of tip of exit tube, and formation of plug of opaque material and endoöperculum, × 1400. 49; minute monocentric thallus, × 1100. 50; young clavate resting spores on surface of substratum; rare intramatrical spore at H, × 1100. 51–53; irregular and spherical resting spores, × 1100. 54; rare intramatrical resting spore with attached zoospore case and germ tube, × 1100. 55; thallus with two resting spores, × 1100. 56; germination of resting spore, × 1100.

TAPHRINA OSMUNDAE NISHIDA AND TAPHRINA HIGGINSII SP. NOV.

A. J. Mix

(WITH 1 FIGURE)

An interesting feature of the genus *Taphrina* is the high state of development attained on ferns. About twenty species of this genus occur on ferns, seven of them having been described rather recently (**2, 3**). A few undescribed species are in the writer's possession and it is possible that additional forms may yet be discovered.

Although the clavate type of ascus prevails among fern-inhabiting species of *Taphrina,* as pointed out long ago by Giesenhagen (**1**), considerable variation in ascus-form exists. There is also marked variation in ascus-size, ranging from *Taphrina Hiratsukae* Nish. with asci 13–30 $\mu \times$ 4–7 μ, stalk-cells 5–8 $\mu \times$ 3–5 μ, to *T. lutescens* Rostr. with asci 27–75 $\mu \times$ 6–11 μ (without stalk-cell). Asci with or without stalk-cells are well represented, the former by *Taphrina Hiratsukae* and other species, the latter by *T. filicina* Rostr. and at least one undescribed species.

Host-lesions vary from inconspicuous, unthickened leaf-spots, as in *T. Hiratsukae* and other species, to large galls, as in *T. californica* Mix, or very remarkable outgrowths, as in *T. cornu-cervi* Giesenhagen and *T. laurencia* Giesenhagen.

All three types of mycelial habit are exemplified by fern-inhabiting species of *Taphrina:* the subcuticular habit (*T. Hiratsukae,* etc.), the intercellular habit (*T. filicina,* etc.), and the habit of growing within the epidermal wall. In fact the "wall-habit" of mycelial growth, described by the writer for *T. amplians* Mix and other species (**3**), is known only in fern-inhabiting species and in two species occurring on Monocotyledons.

This paper is concerned with two species of *Taphrina* which seem to climax the series on ferns if not to form a connecting link between the genera *Taphrina* and *Taphridium.*

The first of these species is *Taphrina osmundae* Nishida. This fungus was described by Nishida in 1911 as causing yellow to brown, unthickened spots on leaves of *Osmunda regalis* L. It has been studied from the following specimens:

Taisenji, Pref. Tottori, Japan, July 1, 1924. K. Togashi.
Mt. Iwate, Pref. Iwate, Japan, June 13, 1934. K. Togashi.
Mt. Kirisama, Kyusu, Japan, May 29, 1938. I. Hino.

Yellow to brown unthickened spots occur on the leaves. These spots are variable in size, usually small, but sometimes involving a whole leaflet. A sparse white powdery layer of asci covers the lower surface of the spot and, less commonly, similar smaller areas can be seen on the upper surface.

Mycelium of the fungus grows within the outer epidermal wall, appearing, in the earliest stages seen, as septate hyphae of short segments, and sending (in some cases) unspecialized hyphal branches (haustoria) into the cell-cavity beneath (FIG. 1; *A, B, D*).

Growth of the mycelium results in the hollowing out of a large locule in the cell wall with partial or complete obliteration of the cell cavity beneath (FIG. 1, *C*). Shortly before ascus-formation each locule is seen to be occupied by a non-septate and multinucleate hyphal cell, entirely separate from similar cells in adjacent wall-locules. Whether this condition has been reached by loss of septa from the hyphae seen earlier, or by enlargement of individual cells of the young mycelium is not known.

Spore formation usually (though not always) begins before ascus-emergence and wall-locules may be seen containing numerous conidia. Ascospores have not been identified with certainty, though occasionally a few rounded uninucleate bodies have been seen, larger than the conidia, which may perhaps give rise to the latter by budding or by division. Spore formation occurs in a peripheral layer of protoplasm, leaving a large vacuole in the center of the cell.

The ascus emerges by rupturing the outer wall of the locule, appearing first as a small papilla, which gradually enlarges and assumes the shape of the mature ascus (FIG. 1, *E, F, G*). As this process begins, it is seen that the hyphal cell occupying the wall-locule is enclosed in a definite thin membrane. At some time dur-

ing or after emergence a septum forms across the basal portion of the ascus so that, at maturity, each ascus is provided with an empty stalk-cell. The stalk-cell is somewhat triangular in outline except that it is expanded into a foot which remains within the locule.

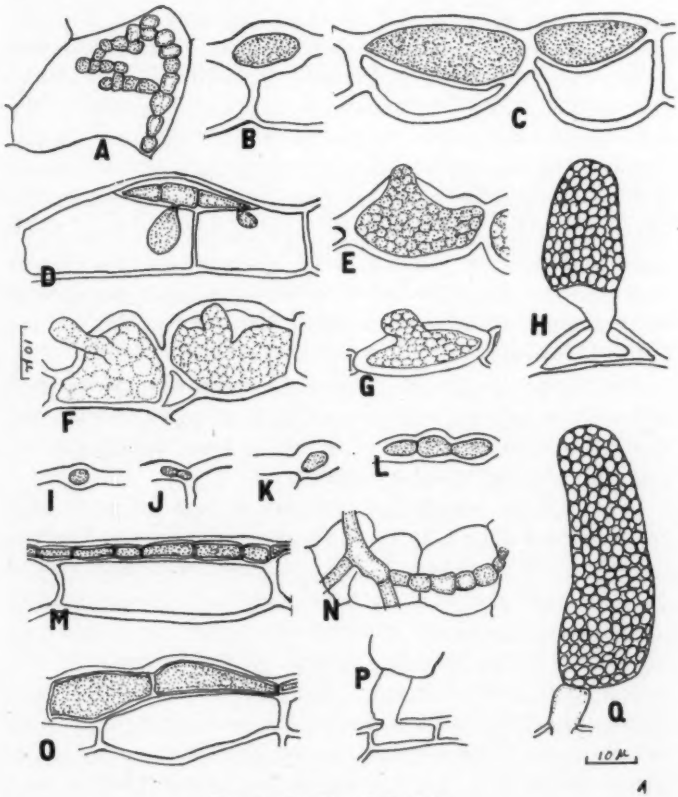

FIG. 1. Species of *Taphrina*.

The mature ascus (FIG. 1, *H*) contains a very large number of conidia, closely packed in a peripheral layer.

Dimensions are: Asci, 26–63 $\mu \times$ 17–27 μ (average 42 $\times$ 21 μ); stalk-cells, 6–17 $\mu \times$ 8–17 μ (average 9 $\times$ 16.6 μ); conidia 3–4 $\mu \times$ 2–3.5 μ (average 3.6 $\times$ 3 μ).

The second fungus occurs on *Osmunda cinnamomea* L. It was collected at Pine Mountain, Blue Spring Farm, Hamilton, Georgia, May 26, 1938, by Dr. B. B. Higgins, who kindly sent material to the writer in October of the same year.

This fungus appears to have been collected earlier. Two packets of material are in the Herbarium of the Department of Plant Pathology, Cornell University, labelled as follows: "Curl of Osmunda cinnamomea, Botanical Dept. Cornell Univ. 9601 (Virginia Plants) Coll. by Wm. A. Murrill, Blacksburg, Va., June–Aug. 1897." The following has been added in another hand: "Taphrina filicina." This labelling appears to indicate that recognizable asci of a species of *Taphrina* were at some time present on the specimens. The leaf-spots are very like those on the Georgia material, but a careful search of the whole collection failed to reveal any asci. Microscopic examination showed a few epidermal wall-locules apparently containing mycelium, and it is highly probable that this is a collection of immature material of the fungus found in Georgia.

The Georgia fungus on *Osmunda cinnamomea* causes small, yellowish, unthickened leaf-spots, showing, when the fungus is mature, a sparse powdery layer of asci on the lower surface (and occasionally also on the upper surface).

In early stages septate mycelium may be observed in the outer epidermal wall (FIG. 1, *I–N*). In a few cases haustoria have been observed. The mycelium enlarges, forming a wall-locule (FIG. 1, *O*) in the same manner as *Taphrina osmundae*. The enlarged locule ultimately contains a multinucleate hyphal-unit in which conidia differentiate from a peripheral zone of protoplasm. This occurs before ascus-emergence. The ascus pushes out through the upper wall of the locule, appearing first as a small papilla. The mature ascus, containing numerous conidia closely packed against the ascus-wall (FIG. 1, *Q*), is cut off by a septum from an empty stalk-cell. The free portion of the stalk-cell is cylindric and the basal portion, widened into a foot, remains within the wall-locule (FIG. 1, *P*).

Since this fungus is morphologically different from *Taphrina osmundae*, it is herewith described as a new species, named in honor of its collector.

Taphrina Higginsii sp. nov.

Mycelium crescit in loculo quid format in muro externo epidermidis utraeque paginae foliae. Ascus unus emergit ex loculo. Asci sunt hypophylli aut amphigeni, oblongi, apice rotundati, 40–80 μ longi et 13–23 μ crassi. Cellula basilaris est cylindrata, angustior quam ascum, pedicellata, in loculo muri inserta. Ascosporae non visae sunt. Conidia numerosa sunt, 2–5 $\mu \times$ 1.5–4 μ. Fungus efficit maculas parvas (usque ad 5 mm. diam.) flavas in foliis vivis *Osmundae cinnamomeae* L. Foliae non sunt deformatae. Blue Spring Farm, Pine Mountain, Hamilton, Georgia, May 26, 1938, B. B. Higgins.

Mycelium grows in a locule which it forms in the outer wall of the epidermis of each surface of the leaf. One ascus emerges from a locule. Asci are hypophyllous or amphigenous, oblong, rounded at the apex, 40–80 μ long and 13–23 μ broad (average 53 $\mu \times$ 19 μ). The stalk-cell is cylindric, narrower than the ascus, 10–17 $\mu \times$ 8–10 μ (average 12.5 $\mu \times$ 9.6 μ). Ascospores have not been seen. Conidia are numerous, 2–5 $\mu \times$ 1.5–4 μ. The fungus causes small (up to 5 mm. diam.) yellow spots on living leaves of *Osmunda cinnamomea* L.

Type material in the Mycological Herbarium, University of Kansas. Duplicate material in the herbarium of the Georgia Agricultural Experiment Station.

These two species of *Taphrina* seem to afford a climax to wall-inhabiting forms in that each wall-locule is occupied by a single multinucleate ascogenous cell, producing a single ascus. Since ascospores have not been seen, it is not impossible that spore formation may occur in the manner of the genus *Taphridium*. Species of *Taphridium*, however, besides being subepidermal in habit, produce a thick-walled chlamydospore whose endospore emerges to form the sporangium, whereas in *T. osmundae* and *T. Higginsii* the chlamydospore, if it can be so called, has a single membrane and the cell itself elongates to become the ascus.

Cytological study of these fungi is obviously needed. Fresh material of *T. Higginsii* was collected, in the type-locality, on May 26, 1941, but the fungus was immature, and only early stages of mycelial development were to be observed.

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EXPLANATION OF FIGURE

FIG. 1. *Taphrina osmundae*. *A–D*, development of mycelium within the epidermal wall; *A*, as seen from above; *B*, *C*, showing enlargement of wall-locule; and *D*, presence of haustoria. *E–G*, stages in emergence of asci. *H*, mature ascus showing stalk-cell and foot. *T. Higginsii*. *I–O*, development of mycelium in the wall and formation of locules. *P*, lower part of ascus showing stalk-cell and foot. *Q*, mature ascus.

NEW GENERA OF FUNGI. III *

ROLF SINGER

The present series of "New Genera of Fungi" deals exclusively with agarics. These genera, including one subgenus, are proposed in an effort to contribute to the revision of the generic taxonomy of these fungi, and they are based on certain atypical species that are not allied to anything now known within the existing genera. These are: *Pleurotus tessulatus* (Bull. ex Fr.) Gill., *Pleurotus japonicus* Kawamura, *Gymnopus praemultifolius* Murr., *Pleurotus porrigens* (Pers. ex Fr.) Gill and *Pleurotus lignatilis* (Pers. ex Fr.) Gill. (*sensu* Kühner), *Omphalia Postii* (Fr.) Karst. (*sensu* A. H. Smith) and *Clitocybe brevibasidiata* Sing., *Marasmius squamosidiscus* Murr., *Nolanea Strobilomyces* Murr., *Agaricus trisulphuratus* Berk., and also *Naucoria juruensis* Henn. Most of these species have been described in or transferred to several genera, or are completely out of place in the genus to which they have been referred in the literature. This is not unexpected since they did not resemble the types of their respective genera very closely in the first place, and their position had been determined mainly or exclusively on the basis of macroscopical characters. The writer has studied their macroscopical, microscopical, and chemical characters, and since these were found to be in disaccord with the characters of the established genera, new generic names had to be proposed for them.

1. **Hypsizygus** Sing. gen. nov.

Tricholomatacearum genus; carpophoro pigmento fere destituto, clitocybeotricholomatoideo atque pleurotoideo; mycelio ad ramos arborum ascendente, haud luminescente, albo; pileo sicco, saepe rimoso-areolato; cuticula ex hyphis repentibus filiformibus, levibus consistente, aegre differentiata; lamellis adnexis vel adnatis, neque decurrentibus nisi dente inconstante, nec profunde sinuatis neque emarginatis nisi in uno latere carpophororum paucorum; spo-

* The first part of this series appeared in MYCOLOGIA **36**: 358–368. 1944; the second part in *Lloydia* **8**: 139–144. 1945.

ris in cumulo albis, globosis vel subglobosis, levibus, inamyloideis, membrana simplici, dein subincrassata institutis, parvulis; basidiis granulatione carminophila destitutis; cystidiis et cheilocystidiis nullis; tramate lamellarum regulari, ex hyphis *Clitocybarum* modo dispositis efformato; subhymenio perangusto, filamentoso-intertexto-ramoso; stipite saepe curvato vel subexcentrico, evelato, firmo, solido; carne haud revivescente, ex hyphis inamyloideis, fibuligeris consistente. Ad truncos ramosque vivos arborum frondosarum.

The type species is **H. tessulatus** (Bull. ex Fr.) Sing. comb. nov. [*Pleurotus tessulatus* (Bull. ex Fr.) Gill.] This is what is called *Pleurotus ulmarius* by all American authors. The true *Pleurotus ulmarius* of Europe, *i.e.*, the species now generally considered to be that species by recent European mycologists, has rightly been transferred to *Lyophyllum* Karst. em. Sing. because of its basidia which show a distinct carminophilous granulation (the most constant and reliable character of the genus *Lyophyllum* and two other closely related genera). The American species has ordinary basidia without any carminophilous granulation in any stage of development. It must, therefore, be different from the European *Pleurotus* or rather *Lyophyllum ulmarium*, at least in the sense of the modern authors. Since the American species has all the characters of *Pleurotus tessulatus* such as shown in the descriptions of Fries, the figure of Bulliard, and the few specimens in the herbaria so determined, we think that this specific epithet should be transferred to a new generic name based on the plant as described by the American authors under the name of *Pleurotus ulmarius*.

Hypsizygus is close to *Clitocybe, Tricholoma, Omphalotus,* and *Pleurocybella* (see under no. 4).

Clitocybe differs in adnato-decurrent or deeply decurrent lamellae which is one of the basic characters of that genus; also in the fact that the spore walls in *Clitocybe* remain thin to extremely thin, and have no tendency to become somewhat thick as in *Hypsizygus;* besides their shape is rather unusual in *Clitocybe,* at least among the smooth-spored species. The parasitic habit of *Hypsizygus* has no parallel among the Clitocybes where lignicolous species are a small minority, and these always grow on very decayed wood near the ground, not high up on the branches or in the wounds of the trunk as does *Hypsizygus*.

Tricholoma differs from *Hypsizygus* in the absence of clamp connections, as far as the majority of the species is concerned; only

a few have clamp connections (sect. *Rigida*), and these do not seem particularly close to *Hypsizygus*. They differ in their characteristic and constant emarginate-sinuose attachment of the lamellae to the stipe, in extremely thin to thin spore walls, in different spore shape, and in their humicolous habit as saprophytes in and outside the woods.

The frequently eccentric stipe and the parasitic growth on living trees has naturally induced the older mycologists to consider this species as a *Pleurotus*. However, *Pleurotus* is a collective genus, and what now is considered as *Pleurotus sensu stricto* is quite different from *Hypsizygus*, so different it can hardly be called related at all. The irregular trama, the decurrent lamellae, the cheilocystidia, the frequently colored, cylindric spores and the broad, well differentiated subhymenium of *Pleurotus* are only a few characters that readily separate it from *Hypsizygus*. *Omphalotus*, one of the groups split from *Pleurotus*, based on *Pleurotus olearius*, has the spores more like those of *Hypsizygus*, but the abundant and peculiar pigment, the strange cystidiform sterile bodies of the hymenium, the strongly decurrent lamellae, the luminescence and the more irregular structure of the trama separate it from *Hypsizygus*. *Lentinus* differs because of its reviving quality due to the thick walled hyphae, and—more important—because of the cylindric spores that put it in the tribe made up by *Pleurotus, Lentinus, Panus, Asterotus; Anthracophyllum* and *Phyllotopsis* rather than in the tribe Clitocybeae where *Hypsizygus* undoubtedly belongs.

We therefore propose a new genus, emphasizing its habitat in its name. There are probably other species belonging here, *e.g. Clitocybe circinata* (Fr.) Karst. sensu Sing. (**1943**) which is very close to *H. tessulatus*.

2. **Lampteromyces** Sing. gen. nov.

Tricholomatacearum genus; carpophoris pleurotoideis, luminescentibus; pileo fibrilloso, haud viscoso; lamellis profunde decurrentibus; basidiis haud granulosis in solutione acetocarminica; sporis hyalinis, giganteis, globosis, inamyloideis (nec pseudoamyloideis), levibus, membrana saepe crassiuscula instructis, in cumulo albidolilascentibus; cystidiis cheilocystidiisque indistinctis vel nullis; tramate lamellarum regulari, ex hyphis subflexuosis vel strictis, hyalinis, haud dense intertextis consistente; subhymenio angusto; stipite excentrico vel laterali, firmo-tenaci, distincte annulato e velo persistente quod

ex hyphis filamentosis constat; carne ex hyphis inamyloideis, fibuligeris consistente. Ad ligna.

This genus is based on *Pleurotus japonicus* Kawamura, *Journ. Coll. Sci. Imp. Univ. Tokyo* **35**(3) : 2. 1915, which was transferred to *Armillaria* by Imai, and is now renamed **Lampteromyces japonicus** (Kawamura) Sing. comb. nov. It was temporarily admitted in *Pleurotus* as a separate section by the present writer, but a personal examination of specimens[1] shows that it is not merely the shape of the spores that separates this species from *Pleurotus* but the structure of the trama which is irregular-subintermixed in *Pleurotus,* and the structure of the subhymenium which is a broad, well differentiated layer in *Pleurotus.* Adding such chemical-physiological characters as the presence of a poisonous and a luminescent substance (hence the name *Lampteromyces* = lantern fungus) one is convinced that *Lampteromyces* is generically different from *Pleurotus.* It appears to be an abundantly characterized genus, probably close to *Laccaria* which differs by the either elongate or echinate spores, the central stipe and the lack of a veil, also by the lack of a poisonous and a luminescent substance, and by its usually non-lignicolous habit.

3. **Pleurocollybia** Sing. gen. nov.

Tricholomatacearum genus; carpophoris abundanter pigmentatis, collybioideo-pleurotoideis; pileo glabro, hygrophano, tenui, depresso vel umbonato, ellipsoideo vel circulari; epicute ex hyphis horizontalibus, filamentosis consistente, dermatocystidiis destituta; lamellis adnexis vel subsinuato-adnatis, densis, tenuibus; sporis in cumulo pure albis, minutis, inamyloideis (nec pseudoamyloideis), levibus, subglobosis; basidiis granulatione carminophila destitutis, tetrasporis; cystidiis cheilocystidiisque nullis; tramate lamellarum regulari, ex hyphis subparallelis vel parallelis, pro ratione latis sed satis elongatis, moderate tenui-tunicatis consistente, tenui (25–45 μ in diametro); subhymenio ex elementis parvulis efformato, bene delimitato, cellulari; stipite excentrico, saepe obliquo, tenuiculo, spongioso-farcto, evelato; carne plus minusve amara, ex hyphis inamyloideis, haud fibuligeris consistente. Ad ligna putrida.

The type is **Pleurocollybia praemultifolia** (Murr.) Sing. comb. nov. (*Collybia praemultifolia* Murr. and *Gymnopus praemultifolius* Murr., *Proc. Florida Acad.* **7**: 129, 107. 1945).

[1] The writer is indebted to the Headquarters of the U. S. Army in Japan, for kindly forwarding specimens of this fungus to this laboratory.

It differs strongly from *Collybia* in the eccentric pileus (hence the generic name) and—more important—the clampless hyphae, also in the very minute spores (2.7–3.5 × 2.5–3.2 μ). It is more closely related to *Podabrella* Sing. and *Callistosporium* Sing., differing from the former in the pure white spore print and abundant pigmentation, also in being eccentrically stipitate and extremely small spored, and from *Callistosporium* in the lack of the bright colored pigment bodies in the hyphae, basidia, and spores, also in being eccentrically stipitate, and in the subglobose, minute spores. The type of the genus has been studied by the writer in Gainesville, and the specimens collected by him personally in South Florida have been compared and found to be identical. This is a well characterized genus which, in spite of being monotypic, is separated from its relatives by a wide hiatus.

4. **Pleurocybella** Sing. gen. nov.

Tricholomatacearum genus; carpophoris haud pigmentatis, pleurotoideis; pileo glabro; epicute paulum differentiata, haud gelatinosa; lamellis adnato-subdecurrentibus vel attenuatis concurrentibusque; sporis in cumulo albis, hyalinis, subglobosis vel ellipsoideis, tenuitunicatis, inamyloideis (nec pseudoamyloideis), minutis; basidiis minutis, granulatione carminophila destitutis, tetrasporis; cystidiis cheilocystidiisque nullis; tramate lamellarum irregulari, subintermixto vel intermixto, ex hyphis tenuitunicatis, dein subcrassotunicatis (0.5–1.0 μ vel plus), nonnulis interdum per hymenium rumpentibus crines hyphales cystidiformes efformantibus, inaequalibus nec parallelis consistente; stipite nullo vel excentrico; velo nullo; carne carnoso-subtenacella vel carnoso-submolli, ex hyphis membranis subincrassatis institutis, inamyloideis, fibuligeris consistente. Ad ligna.

The type of the genus is **Pleurocybella porrigens** (Pers. ex Fr.) Sing. comb. nov. = *Pleurotus porrigens* (Pers. ex. Fr.) Gill. This species is not a *Pleurotus* in the present sense, considering its short spores and the lack of a strongly limited subhymenium. The writer has temporarily considered it as a species of the genus *Scytinotopsis* but this later genus, though it has the short spores of *Pleurocybella,* is nevertheless different. At least a portion of the trama of the pileus is gelatinized in *Scytinotopsis,* and the mediostratum of the trama of the lamellae is regular; the cuticle is more differentiated, and is strongly pigmented. It appears that *Scytinotopsis* (or rather *Resupinatus* S. F. Gray since Gray's work has

been shown to be post-Friesian) is closely related to *Geopetalum* (= *Acanthocystis*) whereas *Pleurocybella* is closely related to *Clitocybe* and *Hypsizygus,* and perhaps nearest to *Nothopanus*. *Clitocybe* differs in the central stipe, the decurrent lamellae, the structure of the trama of the lamellae which is never as strongly irregular as it is in *Pleurocybella*. *Hypsizygus* differs in regular gill trama, and the spores that become thick-walled, also in much broader lamellae which are attached to a stipe but not adnate-subdecurrent. As for *Nothopanus,* we at first attempted to emend that genus in order to incorporate *Pleurocybella,* because there is no doubt in our mind that *Pleurocybella* represents the boreal group, and *Nothopanus* the tropical group of fungi with a common ancestry. Yet, the gap between them is too great, and the species belonging to *Pleurocybella* too dissimilar externally from those belonging to *Nothopanus* to be combined into a single genus. *Nothopanus* has a reviving trama if dried out *in situ* and remoistened, the lamellae are broad, especially if compared with the diameter of the context, and distant; the surface of the pileus is radiately fibrillose and usually pigmented (excepting some occasional specimens of *N. eugrammus*). *Pleurocybella* has a putrescent trama, the lamellae are rather narrow to very narrow, and remarkably crowded in the type species; the surface is not fibrillose and no more pigmented than the rest of the carpophore. In addition, the type species has a slight odor of *Collybia dryophila* or cyanic acid (which it actually discharges in fresh condition) whereas the *Nothopani* are completely odorless.

A second species which is probably congeneric with *Pleurocybella porrigens,* is *Pleurotus lignatilis* (Pers. ex Fr.) Gill. *sensu* Kühner, This may appear surprising at first glance—if the well developed, eccentric stipe is taken into consideration. However, this is, macroscopically, the only character that does not agree perfectly with the other important characters of the type species of *Pleurocybella,* and microscopically, these species are extremely similar, except for the slightly more elongate spores of *P. lignatilis*. Kühner states that this species constitutes "un type à part . . . qui mériterait d'être séparé" [from *Pleurotus*]. It has generally been taken for a *Clitocybe* in recent taxonomic papers (Heim & Romagnesi, Singer), yet it differs in the structure of the trama, thick walls of

the tramal hyphae, the eccentric stipe and the less decurrent lamellae. One will notice that these are precisely the characters by which *Pleurocybella porrigens* differs from *Clitocybe*.

5. *Omphalina* subgenus **Romagnesia** Sing. subgen. nov.

Tricholomatacearum subgenus; carpophoris hygrophoroideo-omphalioideo, pigmento abundante flavo *Omphalotum* et *Gymnopilos* in mentem revocante imbutis quando sub microscopio examinata sunt; pileo dein infundibuliformi, glabro, hygrophano, diaphano; epicute ex hyphis intertextis, repentibus, filamentosis consistente; lamellis tenuibus, decurrentibus; stipite farcto, centrali, moderate tenui, evelato; sporis in cumulo albis, levibus, ellipsoideus, inamyloideis (nec pseudoamyloideis); basidiis tetrasporis, granulatione carminophila destitutis; cystidiis raro obviis, clavatis, inconspicuis, vel nullis; tramate lamellarum angustissimo, regularissimo, ex hyphis filamentosis, hyalinis, tenuibus, parallelis efformato, tertiam modo partem spatii inter hymenia occupante; subhymenio quoque tertiam partem eius spatii occupante, id est summa amborum subhymeniorum duas tertias spatii interni occupantibus, hyalino, irregulari-intermixto; stipite centrali, farcto, evelato, tenui sed haud cartilagineo; carne ex hyphis tenuitunicatis, fibuligeris vel haud fibuligeris, inamyloideis constituta. Ad (vel inter) Bryophyta.

The type species, **Omphalina Postii** (Fr. *sensu* A. H. Smith) Sing. comb. nov. = *Omphalia Postii* (Fr.) Karst. *sensu* A. H. Smith is not a true *Omphalina*.[2] Its very peculiar pigment, dissolved and yellow, and coloring the whole preparation yellow, as is also the case in *Omphalotus olearius, Gymnopilus sapineus,* and the hymenophore of *Pulveroboletus auriporus,* differs strongly from the dusky incrusting pigment of *Omphalina;* the trama is very different, its elements are more thick-walled, irregularly arranged and the trama much broader in relation to the subhymenium; the lamellae are more distant, and the habitat more varied. Searching for a genus where *O. Postii* could be classified we have also thought it possible that this species is a *Hygrocybe* rather than a tricholomataceous plant. However, the size of the basidia and the structure of the trama do not in the least justify the suspicions which are brought about by the orange color that is reminiscent of *Hygrocybe Cantharellus* (Schw.) Lange. However, this color

[2] The generic name *Omphalia* (Fr.) Quél. cannot be retained because S. F. Gray took up Persoon's sectional name *Omphalia* as a genus in 1821, and this status is valid since Gray's books are post-Friesian. It thus has priority over *Omphalia* (Fr.) Quél. which is not identical. The latter can, however, easily be replaced by *Omphalina* Quél.

also reminds one of another genus, *Hemimycena,* where several species, among them the common *H. fibula,* are as orange as *O. Postii.* A careful comparison of the structure of the trama of all these species with the trama of *O. Postii* revealed that the structure found in *O. Postii* does not occur in *Hemimycena.* Aside from this, the *Hemimycenae* differ in other characters, *e.g.,* the presence of cystidia or cheilocystidia, the constant presence, in four-spored forms, of clamp connections, the epicutis made up of diverticulate hyphae or dermatocystidia, etc. It is hard to tell whether or not the similarity of the color means anything phylogenetically (it has certainly influenced Fayod's opinion), but it is obvious that *Hygrocybe, Omphalina Postii,* and the orange species of *Hemimycena* (or perhaps rather *Marasmiellus* [3]) are not congeneric.

This genus is also different from *Clitocybe,* because of the structure of the trama and because of the frequent occurrence of constantly clampless forms which are never observed in *Clitocybe,* and finally because of the characteristic pigment that is never found in *Clitocybe.* Not knowing about the existence of clampless forms in *Romagnesia,* the author has described a new species of this same group in *Clitocybe* under the name of *Clitocybe brevibasidiata* Sing. This Central-Asiatic species should now be known as **Omphalina brevibasidiata** (Sing.) Sing. comb. nov. It differs from *O. Postii* (Fr.) Sing. in the presence of clamp connections. The genus *Omphalotus* Fayod has the same pigment as *Romagnesia* (at least microscopically), yet the much more irregular trama, the fasciculate, lignicolous habit, its poisonous and luminescent properties, and the much fleshier, robust carpophores make it impossible to consider a generic identity of these genera.

The name *Romagnesia* has been selected in view of the valuable data on *Omphalia* and the affinities of this genus, published by our distinguished French colleague Henri Romagnesi.

[3] The type of *Marasmiellus juniperinus* Murr. has been studied by the writer, and it appears that this species belongs to *Hemimycena* (near the *Rameales*-group). Since Murrill has designated this species as the type species of the genus *Marasmiellus* it now becomes necessary to replace the generic name *Hemimycena* Sing. by Murrill's name, and place *Hemimycena* in the synonymy of *Marasmiellus.*

6. **Ripartitella** Sing. gen. nov.

Leucocoprinacearum genus; carpophoris pluteoideo-pleurotoideis, pigmento membranali praeditis; pileo squamuloso, squamulis e catenulis elementorum hyphalium breviusculorum haud sphaerocystiformium constantibus; lamellis adnatis vel subliberis; sporis in massa albis, hyalinis, minutis, subglobosis, echinulatis, inamyloideis et numquam pseudoamyloideis; basidiis normalibus familiae; cystidiis ventricosis in parte inferiore, sagittatis vel tenui-palatis crystalliferis *Melanoleucarum* modo in parte superiore, ad latera et prope aciem lamellarum dispersis; tramate subregulari, dein subirregulari, ex hyphis neque intermixtis neque parallelis consistente; stipite excentrico vel centrali, velato sed vix persistenter annulato; carne ex hyphis haud amyloideis, fibuligeris consistente. Ad ligna, raro ad terram humosam.

The type with its synonymy has been described in the writer's "Type Studies on Agarics II" (*Lloydia* **9**: 128. 1946); it is *Ripartitella squamosidisca* (Murr.) Sing. It occurs from Florida south to southern Brazil. It is very similar to *Ripartites* microscopically, and as far as **Ripartites strigiceps** (Fr.) Sing. comb. nov. (*Agaricus strigiceps* Fr.) is concerned, it resembles it to a certain degree, even macroscopically. However, we do not think that the two genera are actually closely allied. On the contrary, it appears that they belong to different families, *Ripartitella* being obviously closely related to *Cystoderma* because of the way its lamellae are attached to the stipe, and because of the similarity of the cystidia of *Ripartitella squamosodisca* with those of *Cystoderma cinnabarinum,* and also because of the short hyphae making up the scales of the pileus. The two genera differ, however, in three important characters: (1) the structure of the covering layer of the pileus and stipe which is an epithelium in *Cystoderma,* and a trichodermium in *Ripartitella;* (2) the wall of the spores which is always smooth in *Cystoderma* whereas it is echinulate in *Ripartitella;* (3) the eccentric position of the stipe in a large number of carpophores of the *Ripartitella* whereas *Cystoderma* is centrally stipitate as the rest of the Leucocoprinaceae.

7. **Cystoagaricus** Sing. gen. nov.

Leucocoprinacearum genus; carpophoris minoribus lepiotoideis, pigmento plerumque incrustante membranas hypharum, obscuro vel laetissimo; pileo elato vel applanato, furfuraceo vel squarroso-spinoso; epicute velum universale praesentante, e corpusculis furfuraceis vel pilosis consistente, quae epithelio pseudoparenchymatico vel catenulis, quarum elementa sphaerocystoidea

(globosa vel ellipsoidea) sunt, efformantur; lamellis liberis vel adnexo-subliberis, ascendentibus vel subhorizontalibus, latiusculis; sporis in massa subpurpureo-fuscis, sub microscopio obscure brunneo-fuscis vel purpureo-fuscis, KOH ope interdum subolivascentibus, minoribus (10 μ longitudine haud attingentibus), membrana duplica, iodi ope haud mutata, levi, primo hyalina, dein obscure colorata, ad porum germinativum indistinctum vel distinctum saepe truncatum interrupta instructis, circumferentia curvata vel angulato-nodulosa gaudentibus, reniformibus vel polyedricis inaequilateralibusque, saepe noduloso-undulosis et frequenter vel semper parte hilari excessive protracta nodiformi, subelongatis vel subisodiametricis; basidiis normalibus minusculis, latiusculis, tetrasporis; cystidiis ad latera lamellarum nullis; cheilocystidiis praesentibus, in typo pluricellularibus, e catenulis elementorum vesiculosorum, latissimorum consistentibus, ex iis acie lamellarum heteromorpha; tramate regulari, ex hyphis subvoluminosis consistente; stipite squarruloso vel e velo generali furfuraceo saepeque annulato; tegumento stipitis ei pilei analogo; carne tenui vel media; hyphis fibuligeris; ad ligna et in arena humosa.

The type species is **Cystoagaricus Strobilomyces** (Murr.) Sing. comb. nov. (= *Nolanea Strobilomyces* Murr., Fla. Acad. Sci. **7**: 118. 1944, published 1945) which has been collected in 1938 by W. A. Murrill in Alachua County, and by the author in 1942 in Dade County, Florida. I noticed the outstanding characters of this fungus immediately after collecting, but since I found the same plant in the unpublished material prepared by Dr. Murrill at Gainesville, Fla., I waited for its publication which did not come forth until 1945, and then in a genus that has definitely not the slightest affinity to the species in question. We must, therefore, transfer this species—but in order to transfer it to the proper genus, a new generic name had to be adopted.

The difficulty here is not the separation of this new genus from existing genera. The shape of the spores, combined with the structure of the edge of the lamellae and the epicutis, the subfree lamellae which are ventricose, even when ascendant, and the dark color of the spores make it impossible to consider its generic identity with *Inocybe, Deconica, Stropharia,* or *Psathyrella,* and the combination of these correlated characters separates it clearly from *Agaricus* and all other genera of the Leucocoprinaceae in which family it belongs much rather than in the Strophariaceae, or Coprinaceae.

This view is confirmed by the examination of a second species that evidently belongs in *Cystoagaricus, viz.,* a fungus collected

by D. H. Linder in Liberia, and given to me for determination. Though we have not seen the type of *Agaricus trisulphuratus* Berk., we think that it is this species. Here, the covering of the pileus is rather furfuraceous and separable, consisting of an epithelium, and colored brightly rather than dark, and the veil is more distinct, the size larger, and the habitat probably on sandy soil rather than on wood. We propose the new combination **Cystoagaricus trisulphuratus** (Berk.) Sing.

The less constantly angular spores which have a more typical *Agaricus*-color in KOH, and the more *Agaricus*-like external appearance of this plant which was consequently also considered as belonging in *Agaricus* by Berkeley when he described the type specimens from Zanzibar, Africa, also the more distinct veil, the larger size, the habitat, all tend to make the gap between *Cystoagaricus* and *Agaricus* appear to be smaller than it might appear if only *C. Strobilomyces* were known.

In both species, we sometimes observe a phenomenon that is not rare in some groups, namely, the formation of twin spores held together by a common thin perisporium.

In order not to be responsible for a duplication of names, we have taken great care to find out what the genus *Micropsalliota* Höhnel represents. In spite of the general belief that this designates small species of *Agaricus,* we found all the specimens available in the Höhnel Herbarium (Farlow Herbarium) different from *Agaricus* by paler spores which are pseudoamyloid. These species, especially the type species of the genus, fit perfectly into the sections established in *Lepiota;* they differ merely by the slightly colored spores, a character quite common in *Lepiota.* They should be transferred to *Lepiota,* and the genus *Micropsalliota* should be placed in synonymy.

We have also compared the species of the genus *Phaeomarasmius* in its original limits as well as in the limits as broadened by Romagnesi. These species often have an epithelium-like epicutis, or catenulate spherocysts, yet the spores are definitely not of the color seen in *Cystoagaricus,* not to mention their shape. We have previously considered some of the *Phaeomarasmii sensu lato* as belonging to *Naucoria* but it appears that Romagnesi is probably right in referring the non-hygrophanous species to *Phaeomarasmius.* Nev-

ertheless—*Naucoria* can easily be separated from *Cystoagaricus* by the color (rather sordid-brownish) and shape (reniform to subamygdaliform) of the spores and the different shape of the cheilocystidia. The similarity—macro- and microscopical—between *Cystoagaricus Strobilomyces* (Murr.) Sing. and some *Naucoriae* or *Phaeomarasmii* is therefore purely superficial, and does not indicate any affinity.

The genus *Nolanea* is much rather a subgenus of the genus *Rhodophyllus* than an independent genus. In any case, the spores of *Nolanea,* though angular, are of a different shape, an entirely different color (pink rather than purplish-fuscous); the basidia are much larger and not so broad as in *Cystoagaricus;* the *Nolaneae* never show a combination of anatomical characters as found in *Cystoagaricus,* and are always naked (without veil). *Nolanea* (*Rhodophyllus*) and *Cystoagaricus* are not related.

In *Psathyrella,* the lamellae are more broadly adnate, and a combination of a pseudoparenchymatic general veil and septate cheilocystidia of a vesiculose type is never found in that genus; in some species, the spores may appear somewhat angular but they are still different in shape. In the writer's opinion, *Cystoagaricus* and *Psathyrella* are related only insofar as the families to which they belong (Leucocoprinaceae and Coprinaceae) are related with each other.

8. *Conocybe* Fayod, subgenus **Ochromarasmius** Sing. subgen. nov.

A sectionibus generis *Conocybis* omnibus differt sporis minutis, distincte verrucosis stipiteque tenuissimo, cartilagineo. Ad truncos putridos caespitose in Brasilia.

The type species of this new subgenus is *Naucoria juruensis* Henn. the type of which has surprisingly small (4–5.8 × 2.8–3.5 μ), rusty colored, warty spores which usually show a small germ pore at the apex. The stipe reminds one of that of some small *Marasmii* like *M. aciculiformis* B. & C. of the section *Hygrometrici* Kühn. It is covered with dermatocystidia of the capitate type as found on the stipe of *Conocybe tenera* sensu Kühner and related species; these dermatocystidia are hyaline to chestnut colored, and measure

17–19 × 7.5–8.8 μ, the capitulum being 4.2–5.2 μ in diameter. Some of the dermatocystidia, however, are devoid of a capitulum, and are merely broadly ellipsoid, or mucronate. These bodies cause the pruina mentioned by Hennings. This species is certainly not close to *Phaeomarasmius* as implied by Hennings, in spite of the fact that the name *Phaeomarasmius* would perhaps fit our new subgenus better than the genus that is now rightly known as *Phaeomarasmius*. We have therefore chosen a name indicating the spore color (and affinity) of the subgenus in a combination with the old name *Marasmius*, thus making reference to the characters due to adaptation (thin, cartilaginous stipe).

We contrast the new subgenus *Ochromarasmius* to the subgenus **Euconocybe** Sing. subgen. nov. based on the type species of *Conocybe*, and characterized by a thicker, very fragile stipe, and spores that are never at the same time minute and warty.

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NOTES ON THE TREMELLALES OF GEORGIA

LINDSAY S. OLIVE

(WITH 16 FIGURES)

The specimens described here were collected by the writer in the vicinity of Athens, Georgia, during the fall, winter, and spring of 1945–1946. The majority of the thirty-four species listed have not been previously reported from this state. A species of *Platygloea,* apparently not reported since its discovery in Europe, has been found and is redescribed here. A single new species is proposed under the generic name *Seismosarca.* Undoubtedly, a much larger number of tremellaceous species will be found as the survey is extended to other parts of this state, which is characterized by an interesting succession of climatic, topographical, and vegetative zones.

Excellent keys to the identification of most of the Tremellales discovered in this country will be found in a recent publication by Martin (**1944**) and in an earlier paper by Coker (**1920**). Martin's paper also presents a very helpful bibliography on the taxonomy of the Tremellales of North America.

AURICULARIA AURICULARIS (S. F. Gray) Martin. Amer. Midl. Nat. **30**: 81. 1943.

Fructifications were found growing on hickory limbs lying on the ground. They are typical in appearance and texture, but I have found that the range in size of spores is slightly greater than that given by Martin or Coker. They measure 4.9–6.5 × 11.7–17.6 μ. Only three collections of it were made in this area.

Growing on corticate and decorticate hickory limbs, Athens, Georgia. November–December, 1945.

PLATYGLOEA PENIOPHORAE Bourd. & Galz. Bull. Soc. Myc. Fr. **25**: 17. 1909. (FIG. 3.)

The fungus was found growing entirely within the fructifications of a small species of *Dacrymyces.* It is characterized by hyphae

with conspicuous clamp connections, narrow haustorial branches which are frequently found applied to the hyphae of the host, and conidiophores that produce obovate or oval conidia which measure 3.3–4.6 × 5–9.8(12.4) μ. Clamp connections often occur at the bases of the conidiophores. Moreover, each conidium appears to develop with a clamp connection at its base. After several conidia have been shed, an equal number of clamp connections may be observed on the upper parts of the conidiophores, as shown in the figures. The basidia are four-celled, often with a stalk cell at the base, measuring 5–6 × 32–46 μ. Basidiospores are ovate, apiculate, and slightly flattened on one side, and measure 4.6–5.9 × 7.2–9.4 μ.

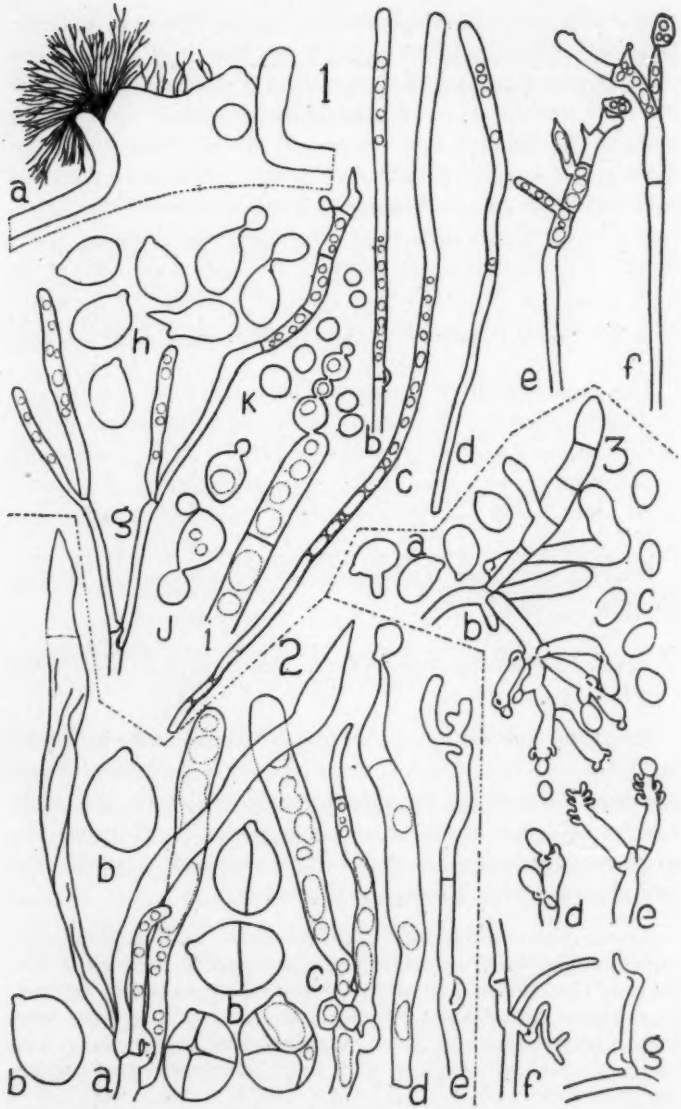
This same fungus was reported by me earlier from North Carolina (**1946**), where it was found parasitizing a *Dacrymyces*. The species, as noted previously by Martin (**1940**), shows considerable variation in the size of its basidia and basidiospores. The specimens which I have collected also show a great deal of variation in size of conidia.

Growing within the fructifications of *Dacrymyces* sp., Athens, Georgia. April 11, 1946.

PLATYGLOEA MIEDZYRZECENSIS Bres. Annal. Myc. 1: 113. 1903. (FIG. 1.)

Bresadola described this species from a collection made in Poland, and there has probably been no other report of it since then. I have examined a part of the Bresadola collection and find it very much like the Georgia collection in general appearance. Moreover, the microscopic characters of the two are considerably alike. The Georgia collection is described as follows:

Fructifications white, very soft, gelatinous, pulvinate, erumpent, anastomosing, surface smooth, individual pustules measuring 0.5–2.5 mm. (Bresadola: 2–4 mm.) in diameter, not exceeding 0.6 mm. in thickness, anastomosing to form patches up to 8 mm. long, basidia borne at the tips of long branched hyphae with clamp connections, composed of a long stalk and a four-celled spore-producing part, measuring in all 5.1–7.2 × 97–268 μ (Bresadola: 4–6 × 75–200 μ), sterigmata variable in length, basidiospores mostly obovate, apiculate, 5.9–8.1 × 9.1–12 μ (Bresadola: 7–9 × 10–13 μ),



FIGS. 1–3. Georgia Tremellales.

germinating by repetition or budding out globose to subglobose conidia, 2.6–5.3 × 2.6–6.5 μ (Bresadola: 3.5–4 × 4–5 μ).

Growing from the perithecial stromata of *Botryosphaeria,* on a *Mimosa* branch lying on the ground, Athens, Georgia, December 19, 1945. Probably rare.

Bresadola reports that in his collection the fungus was growing on the bark of elm. Upon examining a portion of the type specimen, I found that it was growing over a sphaeriaceous fungus on the elm.

Occasionally the basidia germinate abnormally by producing conidia similar to those produced by the basidiospores. In the formation of a basidium, it is interesting to note that the lower part of the probasidium becomes very vacuolate and most of its protoplasmic contents pass into the upper part, after which a cross wall appears, cutting off the empty part (stalk cell) from the upper part which produces the spores. This stalk cell effect frequently is observed at the bases of some rust basidia, as in *Gymnosporangium.* It seems to function in bringing the spore-producing part of the basidium closer to the surface of the gelatinous medium in which it is embedded.

PLATYGLOEA UNISPORA Olive. Jour. Elisha Mitchell Sci. Soc. **60**: 17. 1944. (FIG. 2.)

With the exception of a few details the present collection, which represents the second record of the fungus, is very similar to the type specimen collected in North Carolina. The small waxy gelatinous fructifications are pulvinate or flattened-pulvinate, yellow, orange yellow, or cinnamon brown in color, measuring 0.3–1 mm. in diameter. Paraphyses are scattered among the basidia. As was pointed out in the original description the basidia are mostly one-celled. Although septa sometimes develop, they break down during the formation of the single large basidiospore. The basidiospores are oval to obovate, distinctly apiculate, and measure 10–14 × 14.3–20.2 μ. Not noticed in the original collection is the tendency of the basidiospores to become 2–4-celled. A cytological study of the basidia and spores of this fungus should prove to be of considerable interest.

Only one collection; growing on dead cedar branches lying on the ground, Athens, Georgia. January 18, 1946.

SIROBASIDIUM BREFELDIANUM Möller. Protobasidiomyceten. 1895. (FIG. 10.)

The species seems to have been reported only once previously in this country since its discovery by Möller in South America. Coker (**1920**) found a single specimen of it in North Carolina. One other species, *S. sanguineum* Lag. & Pat., has been collected in North Carolina by Coker (**1928**) and in Maryland by Olive (**1946a**). Both fungi are apparently rare in this country.

The fructifications of the Georgia collection appear as soft, white, gelatinous pustules, measuring 0.5–2 mm. in diameter. They dry to an invisible hyaline film. The fructifications are composed mainly of a few much-branched paraphyses and numerous chains of basidia, generally with clamp connections at their bases. The basidia are borne 3–10 in a chain and vary in shape from sub-globose to pyriform or racket-shaped. They are usually two-celled, sometimes three- or four-celled with oblique, vertical, or sometimes transverse septa, and measure 10.7–17.5 × 16.5–48.5 μ. The basidiospores are generally produced directly from the basidial cells and are therefore sessile, but sometimes they are produced on short cylindrical outgrowths, which, however, do not appear to be true sterigmata. The basidiospores vary from ovate or pyriform to narrowly elliptic, measure 7.4–12.6 × 15.5–28.1 μ, and frequently germinate to produce small oval conidia.

One collection; growing on corticate *Mimosa* limbs, Athens, Georgia. December 14, 1945.

TREMELLA MYCOPHAGA var. OBSCURA Olive. Mycologia **38**: 540. 1946.

This variety of *Tremella mycophaga* Martin seems to be fairly common in our area, always as a parasite of *Dacrymyces,* as it was in the type collection from North Carolina.

Parasitizing *Dacrymyces deliquescens* Duby, *D. minor* Peck, and *D.* sp., Athens, Georgia. Fall–spring, 1945–1946.

TREMELLA CARNEOALBA Coker. Jour. Elisha Mitchell Sci. Soc. **35**: 146. 1920.

There do not appear to be any very important differences between my collection and the material originally described by Coker. I have examined the latter and find that it resembles my collection in macroscopic appearance and hymenial structure. The Georgia collection has clamp connections, which were not reported by Coker, but this is of secondary importance.

The fructifications are rather soft, gelatinous, grayish hyaline to smoky white, some becoming very much corrugated and undulate, flattened, measuring 0.75–3 mm. in diameter, occurring in patches up to 3 cm. in length. Clamp connections are abundant. The basidia are globose to obovate, 2–4-celled, and measure 11.7–16.9 × 13.7–24.1 μ. They proliferate from beneath other basidia. Basidiospores are broadly obovate to globose and measure 6.5–9.1 × 6.6–11.7 μ. They germinate by repetition or bud out conidia in yeast-like fashion.

Growing on much decayed frondose wood, probably *Mimosa,* Athens, Georgia. October 28, 1945. Rare.

TREMELLA LUTESCENS (Pers.) Fries. Syst. Myc. **2**: 213. 1822.

The fructifications are quite large and conspicuous, in our collection measuring up to 3 cm. in diameter and varying in color from apricot yellow to a light faded yellow. They are much folded and lobed. Some of the fructifications are entirely conidial, whereas others are both conidial and basidial. The conidia are yellow, spherical to oblong, and measure 1.8–4.2 × 2.6–5.9 μ. The basidiospores are subglobose to obovate and measure 8.5–10.4 × 11.7–15.6 μ.

Although in a recent publication (**1946a**), I was inclined to follow Martin (**1944**) in considering *T. mesenterica* and *T. lutescens* as distinct species, I do not feel now that this concept is correct. Martin prefers to reserve the name *T. mesenterica* for those forms which may produce both conidia and basidia. He also believes that there exist certain other microscopical differences. I have not observed them. Coker (**1920**), Looney (**1933**), and Bjørnekaer (**1944**) consider these fungi as two different phases of the same

species. Bjørnekaer finds that the phase considered at *T. mesenterica* is the winter stage of *T. lutescens*, and that the latter name applies to the summer phase. My own observations show that measurements of basidia and basidiospores are too intergrading to afford a separation of the two phases into distinct species on this basis.

Collected on corticate frondose limbs, probably of tulip poplar, and on decorticate pine wood, Athens, Georgia. April, 1946.

TREMELLA FOLIACEA (S. F. Gray) Pers. Myc. Eur. p. 101. 1822.

A rather large fructification, 5.5 × 8 cm., and several smaller ones were collected in a single locality. The color is a dark cinnamon brown when moist, blackish when dry. The fructifications are composed of many thin, crowded, undulate lobes. There is not a great deal of shrinkage on drying. The basidiospores measure 6.8–9.1 × 8.2–10.1 μ.

Growing on an old uprooted oak stump, Athens, Georgia. September–December, 1945. Uncommon.

EXIDIA SPICULOSA (S. F. Gray) Somm. Supp. Fl. Lapp. **307**, 1826.

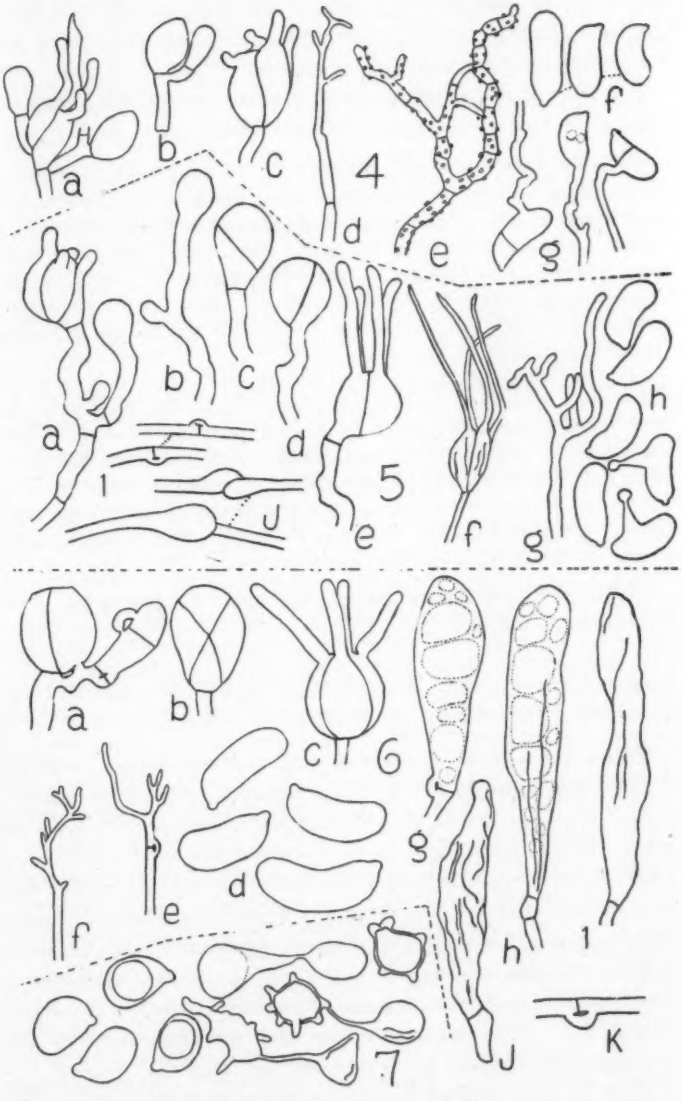
This species is one of our most common jelly fungi. It was found abundantly from fall to spring on fallen branches of frondose trees.

EXIDIA RECISA (S. F. Gray) Fries. Syst. Myc. **2**: 223. 1822.

A very common species in our area, occurring on frondose wood and often attacking dead limbs still on the tree. Found at all times of the year. This and the preceding species seem to be the two most common jelly fungi in our area. Both are probably active lignivores.

EXIDIA SPICULATA Schw. Amer. Phil. Soc. Trans. N.S. **4**: 185. 1832. (FIG. 5.)

Schweinitz discovered the fungus in Pennsylvania, and Burt (**1921**) found it later in Vermont and New York. These are the



FIGS. 4–7. Georgia Tremellales.

only previous records of the species that I have found. I have examined Burt's Vermont collection and find it very similar to our collection in macroscopic appearance.

Since the plant has seldom been collected and is little known, a description of our collection is included here.

Fructifications 0.5–4 cm. in diameter, 3.7 mm. high; pulvinate to expanded and gyrose, the larger fructifications much crumpled and contorted with undulate lobes; chestnut brown to argus brown; sessile, attached centrally or along one edge; upper and lower surfaces smooth, non-glandular, containing numerous small, white calcareous granules somewhat similar to those of *E. nucleata;* drying to a dark brown rugose layer with calcareous granules frequently visible.

Hyphae with numerous clamp connections, often enlarging at the septa. Branched paraphyses present. Basidia subglobose to oval, mostly four-celled, septa vertical or more often oblique, basal septa formed tardily and without clamp connections; basidia measuring 9.3–10.7 × 10.4–15 μ; basidiospores somewhat reniform, 3.9–5.2 × 10.4–13.5 μ, germinating by repetition or sometimes producing small, rod-shaped conidia. Burt gives the basidial measurements as 6 × 9 μ and spore measurement as 4 × 9–10 μ.

Collected on old oak log, Athens, Georgia. December 19, 1945. Rare.

EXIDIA COKERI Olive. Jour. Elisha Mitchell Sci. Soc. **60**: 18. 1944. (FIG. 4.)

This appears to be the second finding of the fungus since its discovery in North Carolina. The Georgia collection is characterized by small, brownish, pustulate fructifications, 100–400 μ in diameter.

The material reported here differs little from the original description of the species. Numerous branched paraphyses, generally roughened with brownish granules, are abundant. The globose to pyriform basidia measure 9.1–11.6 × 9.8–15 μ. The basidiospores are reniform to almost straight cylindrical, apiculate, 4.6–5.2 × 10.4–16.3 μ. They become septate and germinate only by the production of irregular germ tubes in this specimen.

Some of the spores of the type collection were described as becoming 1–4-septate. Later, considering the possibility that some

spores of *Dacrymyces* had become mixed in with those of the *Exidia,* I reëxamined the type collections. No evidence of this was found, however. It is certain that the basidiospores of the Georgia collection almost exclusively become uniseptate and produce irregular germ tubes.

Collected on bark of hickory limb, Athens, Georgia, September 29, 1945, and at Whitehall, near Athens, December 15, 1945. Apparently uncommon, or overlooked because of its inconspicuous fructifications.

EXIDIA NUCLEATA (Schw.) Burt. Ann. Mo. Bot. Gard. **8**: 371. 1921.

This fungus is easily recognized in the field by the hyaline, pinkish, or vinaceous color of its pulvinate or crumpled fructifications and by the presence of numerous white calcareous granules.

Collected on corticate frondose wood, Athens, Georgia. Winter, 1945–46. Not uncommon.

Seismosarca tomentosa sp. nov. (FIG. 6.)

Hyalina vel alba aut fumaginea, interdum dilutissime rosea, primitus albatomentosa, demum levigata, erumpens, pulvinata, plerumque cerebriformis, 1–2 mm. alta, 2–8 mm. lata; fructificationibus interdum confluentibus, intus cartilagineis, extus gelatinosis, siccis flavis usque atris, aliquantulum collapsentibus, marginibus albido-tomentosis. Paraphysibus numerosis, parum vel multum ramosis, 0.7–2 μ crassis; gloeocystidiis elongatis, clavatis, hyalinis, collabentibus, 7.8–13.6 × 24.3–74.7 μ; basidiis subglobosis vel obovatis, 11.7–13.7 × 13.7–19.5 μ, sterigmatis 42–131 μ longis; basidiosporis cylindratis, leviter curvatis, apiculatis, 5.8–7.0 × 16.2–21.1 μ.

Fructifications dull white, hyaline, pinkish, or smoky, white tomentose when young, becoming smooth at maturity, surface sometimes dotted with a few scattered black tubercles; center of fructifications cartilaginous-gelatinous, outer part gelatinous, pulvinate, generally cerebriform, 1–2 mm. thick, 2–8 mm. in diameter, erumpent, sometimes anastomosing; drying to horny, yellowish to black pulvinate masses or membranes, usually with a conspicuous white tomentose border.

Clamp connections abundant; paraphyses abundant, little to much branched, somewhat tortuous, extending beyond the basidia, measuring 0.7–2 μ in diameter, gelatinizing, and becoming indistinct. Gloeocystidia numerous, mostly elongate clavate, contents

hyaline or sometimes becoming yellowish, collapsing soon after maturity, measuring 7.8–13.6 × 24.3–74.7 μ. Basidia subglobose to obovate, mostly four-celled, septa vertical or more rarely oblique, 11.7–13.7 × 13.7–19.5 μ, sterigmata 42–131 μ in length. Basidiospores cylindrical and slightly curved, apiculate, 5.8–7.0 × 16.2–21.1 μ.

Growing on fallen corticate limbs of frondose tree; two collections, Athens, Georgia. November 15 and 22, 1945. Rare.

Two other species of *Seismosarca,* namely *S. hydrophora* Cooke and *S. alba* Lloyd, have been reported in the United States. The new fungus, however, is decidedly unlike these in general appearance and in microscopic details. The tomentose character of its young fructifications and the presence of a whitish border around the dried fruiting bodies make it a fairly distinct species in the field. The whitish border appears to be a kind of subiculum.

SEBACINA EPIGAEA (Berk. & Br.) Bourd. & Galz. Hymén. Fr. p. 39. 1928. (FIG. 7.)

I have found this to be an abundant, but extremely variable species. In my collections the fructifications vary from small separate pustules to a conspicuous and continuous layer, white, gray, or brownish yellow in color, gelatinous in texture, often revealing an arachnoid to corticioid yellowish subiculum on drying, or subiculum absent. The basidia in the Georgia collections measure 8.8–15.5 × 11.7–21.5 μ; the basidiospores, 5.2–8.9 × 7.8–13.8 μ. The most constant character that I have found as an aid to identification is the tendency of the spores to become transformed into irregular thick walled cells, covered with papillae.

Collected on old frondose wood (*Mimosa,* oak, birch, silverberry) and on branches of red cedar, Athens, Georgia. Common throughout the fall and winter.

SEBACINA MOLYBDEA McGuire. Lloydia **4**: 17. 1941.

The species was discovered in Iowa and has since been reported only in North Carolina (**1944**). My collections of it in Georgia differ from previously described specimens mainly in the absence of clamp connections. The basidia tend to be slightly longer.

Two collections on fallen branches, one growing profusely along corticate branches of wild cherry, and the other on corticate and decorticate parts of an old persimmon branch, Athens, Georgia. November, 1945.

SEBACINA PLUMBESCENS Burt. Ann. Missouri Bot. Gard. **3**: 241. 1916.

The fructifications tend to be thicker (320–680 μ) than indicated by McGuire (**1941**) in his monograph of the group. A few small calcareous granules are present. The basidia measure 9.8–12.4 × 11.7–13.7 μ and the basidiospores, 4.9–6.3 × 10.4–15.6 μ. These measurements are slightly smaller than those given by McGuire. Otherwise, the fungus agrees rather well with the latter's description.

Only one collection; growing on bark of fallen tulip poplar branch, Athens, Georgia. April 17, 1946.

SEBACINA PODLACHICA Bres. Ann. Myc. **1**: 117. 1903.

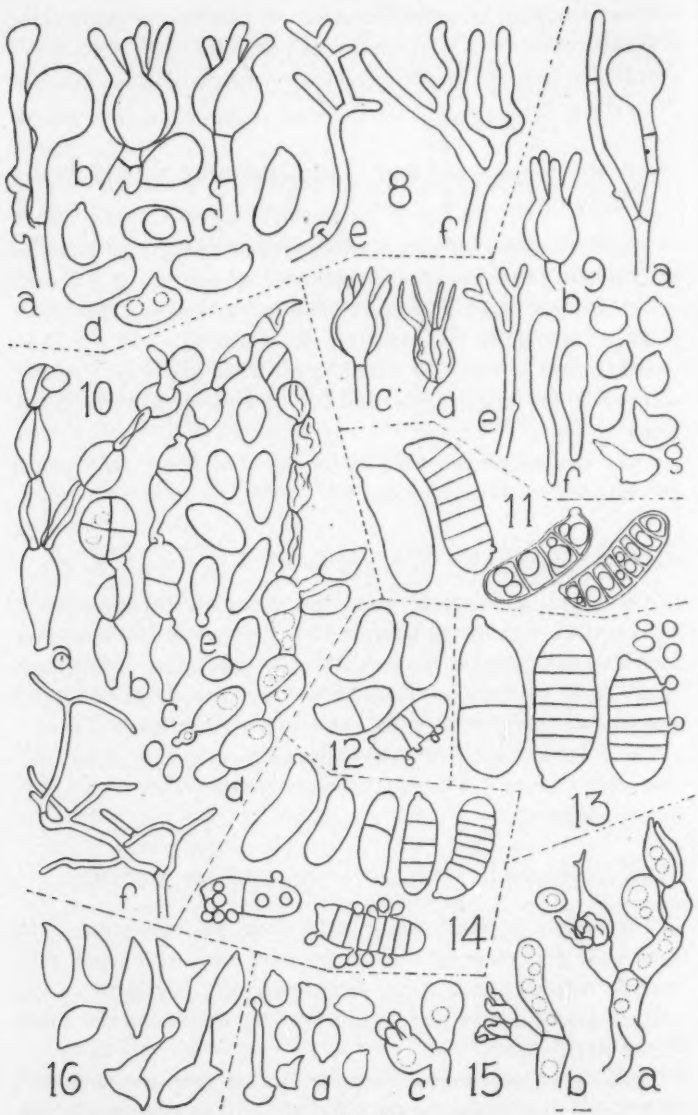
The fungus agrees quite well with McGuire's description of it. It is notably a rather variable species. My specimens show considerable variability in thickness, texture, and color of fructifications, in the presence or absence of calcareous nodules, and in the presence or absence of cystidia and clamp connections.

Growing on fallen corticate branches of oak, elm, silverberry, and wild cherry, Athens, Georgia. October–December, 1945. Fairly common.

SEBACINA SUBLILACINA Martin. Mycologia **26**: 262. 1934.

The fungus is readily recognizable from the standpoint of its thin, slate gray, waxy-gelatinous fructifications, with small, thin-walled, subulate cystidia as seen under the microscope. Calcareous granules were present in one of my collections and absent in the other.

Growing on very rotten corticate limb of tulip tree and on a thelephoraceous fungus on the underside of a corticate birch limb, Athens, Georgia. November, 1945. Apparently uncommon.



FIGS. 8–16. Georgia Tremellales.

DICELLOMYCES GLOEOSPORUS Olive. Mycologia **37**: 543–552. 1945.

I have not yet had the opportunity of obtaining further collections of the fungus since its original description. Considering the fact that one of the type specimens was collected at Savannah, I am including it here. The fungus is a parasite on *Arundinaria* leaves. In spite of its parasitic nature, it has many important characters which would seem to place it among the Dacrymycetaceae.

I am grateful to Dr. G. W. Martin for examining the type collections and bringing to my attention a feature which I overlooked in writing the original description. The hymenium contains, in addition to probasidia and basidia, numerous very slender, unbranched paraphyses with knob-like swellings at the tips. These paraphyses apparently become gelatinized in older fructifications.

DACRYMYCES ABIETINUS (Pers.) Schroet. Krypt. Fl. Schles. **3**: 400. 1888. (FIG. 11.)

The fructifications of this plant are quite small in my collection (0.5–1.6 mm. in diameter) and the spores measure 7.2–8.5 × (15–)18.2–24.7 μ. It is a distinct and easily identified species.

Growing on decorticate pine limbs, Athens, Georgia. April 17, 1946. Uncommon.

DACRYMYCES MINOR Peck. Ann. Rep. N. Y. State Mus. **30**: 49. 1877.

I have experienced considerable difficulty in identifying and separating specimens of *D. minor, D. deliquescens,* and at times *D. Ellisii.* The three species often have many characters that intergrade. These include color, size, and shape of fructifications, presence or absence of clamp connections, spore size, gelatinization of spore septa, and others. I have designated a number of specimens as *Dacrymyces minor* Peck mainly on the basis of their tendency to produce smaller, narrower basidiospores. These become 1–3-septate and measure 3.3–5.9 × 9.1–13.7 μ. The septa sometimes gelatinize as in *D. deliquescens.* No clamp connections were observed on the hyphae. The reader is referred to the monograph

of Brasfield (**1938**) for a more detailed description of the species of *Dacrymyces* listed in this paper.

Collected throughout the fall, winter, and early spring, 1945–46, on corticate and decorticate branches of frondose trees and once on decorticate pine, Athens, Georgia. Common.

DACRYMYCES DELIQUESCENS Duby. Bot. Gall. p. 729. 1829.

In my collections the fructifications measure 0.5–5 mm. in diameter. The species may generally be distinguished from *D. minor* by the presence of somewhat larger basidiospores, but even here there is some intergradation. In our collections the spores become mostly triseptate and measure 4.7–7.8 × 12.8–19 μ. The septa and walls of the basidiospores frequently become gelatinized and thickened. Clamp connections may be present or absent.

Growing on both coniferous and frondose wood, Athens, Georgia. Fall and winter, 1945–46. Common.

DACRYMYCES ELLISII Coker. Jour. Elisha Mitchell Sci. Soc. **35**: 167. 1920.

Generally, this species of *Dacrymyces* may be distinguished from *D. minor* and *D. deliquescens* in that its fructifications average somewhat larger (2–13 mm. in diameter in ours) and are usually attached by white radicating bases. The basidiospores become triseptate and measure 4.3–7.8 × (10.4–)12–17.6 μ. The septa and spore walls apparently do not gelatinize. Clamp connections may be present or absent.

Growing on corticate and decorticate frondose wood, especially oak, Athens, Georgia. Winter and spring, 1945–46. Common.

GUEPINIA ELEGANS Berk. & Curt. Jour. Bot. & Kew. Misc. **1**: 239. 1849. (FIG. 12.)

Our specimens differ in few details from the description given by Brasfield. The fructifications are on the average considerably smaller, not exceeding 5.5 mm. in diameter and measuring 2–6 mm. in height. The spores become 1–3-septate and measure 5.9–7.2(7.8) × 13.0–16.9(18.2) μ. These measurements are somewhat greater than those given by Brasfield.

One collection, growing on very rotten, decorticate frondose wood, Athens, Georgia. December 11, 1945. Rare.

GUEPINIA SPATHULARIA (Schw.) Fr. Elench. Fung. **2**: 32. 1828.

The easily recognized bright orange, spathulate fructifications of this plant were found in lines along old stems of crêpe myrtle, Athens, Georgia. October 23, 1945. Apparently uncommon.

CALOCERA CORNEA Fries. Syst. Myc. **1**: 485. 1821.

Collected twice on rotten frondose wood, Athens, Georgia. October 5, 1945. Not very common.

DACRYOMITRA NUDA (Berk. & Br.) Pat. Essai Tax. p. 31. 1900.

Collected once on corticate pine branches, Athens, Georgia. April 10, 1946. Rare.

GUEPINIOPSIS CHRYSOCOMUS (Bull.) Brasfield. Amer. Midl. Nat. **20**: 226. 1938. (FIG. 13.)

The pezizaeform to expanded fructifications of our collections vary in color from chamois yellow to brown and russet. They are firmly gelatinous and measure 2–7 mm. in diameter. The basidiospores become 7-septate and are quite large, 8.7–12.4 × 17.5–30 μ. Coker's description (**1920**) of *Dacrymyces pedunculatus* (B. & C.) Coker, a synonym of the above, fits our specimens somewhat better than the description given by Brasfield (**1938**).

Collected on corticate pine branches, Athens, Georgia. January–April, 1946. Fairly common.

FEMSJONIA PEZIZAEFORMIS (Lev.) Karst. Mycol. Fenn. **3**: 353. 1876. (FIG. 14.)

This probably represents the first report of the species in the South. Martin says that it is widespread in the cooler parts of the northern hemisphere and gives Ontario and Ohio as the localities for his collections. A description of our specimens follows:

Fructifications erumpent, disc-shaped to pezizaeform, sometimes in the form of irregular pulvinate masses, surface frequently undu-

late or folded, with radicating bases passing through the bark. The fructifications are firmly gelatinous, mostly cadmium to aniline yellow, measure 2–8 mm. in diameter, shrink on drying to orange brown or reddish brown masses, and frequently withdraw into the bark. A smooth hymenium lines the concave part of the fructification, whereas the outside is covered with a whitish tomentum. Clamp connections abundant and conspicuous at all septa. Basidia yellowish; basidiospores measuring 5.2–7.8 × 13–26 μ, becoming 1–8-septate and producing small globose conidia.

Two collections on old corticate branches of tulip poplar, Athens, Georgia. November 29, 1945. Rare.

TULASNELLA VIOLEA (Quél.) Bourd. & Galz. Bull. Soc. Myc. Fr. **25**: 31. 1909. (FIG. 15.)

The species has a wide distribution, having been reported in Europe, the northern United States, and tropical America. This seems to be the first record of it in the southeastern states.

In our single collection, the fungus is broadly effuse, thin but conspicuous, pruinose, not at all gelatinous, pale lilac when moist, drying pale lilac to lilac gray. The hyphae are rather broad, abundantly septate, and devoid of clamp connections. The basidia are typical, usually with four fusiform epibasidia, and the basidiospores are obovate, usually slightly flattened on one side, obliquely apiculate, measure 3.6–4.6 × 5.3–8.1 μ, and germinate by repetition.

Growing on bark of frondose limb, Athens, Georgia. April 16, 1946. Apparently rare in our area.

TULASNELLA VIOLACEA (Johan-Olsen) Juel. Bih. Svensk. Vet.-Akad. Handl. **23**: 22. 1897. (FIG. 16.)

This is the second report of the species in the southern states. It was recently collected by me in North Carolina (**1946**).

The fungus fits well into the description given by Rogers (**1933**) in his monograph of the group. It is rather easily recognized from the standpoint of its general appearance and its peculiarly shaped basidiospores (see FIG. 16). The basidiospores measure 3.9–5.5 × 9.8–16.3 μ and germinate by repetition.

Growing on underside of an old oak limb, Athens, Georgia. January 18, 1946. Collected only once.

GLOEOTULASNELLA PINICOLA (Bres.) Rogers. Ann. Mycologici **31**: 199. 1933.

This appears to be the most abundant member of the Tulasnellaceae in our area. It is an extremely variable species in many ways. Our collections are soft gelatinous or mucous-gelatinous, gray to brown, rather thin, and with an undulate or bumpy surface. The basidia are typical, arising from erect hyphae of rather large diameter. This latter character is one of the most constant and helpful ones in identification. The basidiospores vary from subglobose to subcylindric and measure 3.9–5.2 × 5.9–9.1 μ.

Collected on corticate and decorticate frondose wood (oak, tulip poplar, river birch, hickory, and *Mimosa*). Common from fall to spring, 1945–1946, Athens, Georgia.

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EXPLANATION OF FIGURES

(All figures × 880, unless otherwise indicated.)

FIG. 1. *Platygloea Miedzyrzecensis.* *a*, section of fructification on perithecial stroma of *Botryosphaeria* (× 46); *b–g*, development and sporulation of the basidia (× 600); *h*, basidiospores, some germinating by repetition; *i*, basidium producing conidia; *j*, basidiospores producing conidia; *k*, conidia. FIG. 2. *Platygloea unispora.* *a*, group of basidia; *b*, basidiospores; *c*, basidium and paraphysis-like structure; *d*, basidium sporulating; *e*, paraphysis. FIG. 3. *Platygloea peniophorae.* *a*, basidiospores; *b*, group of basidia and conidiophores; *c*, conidia; *d*, *e*, conidiophores, showing development of clamp connections at apex; *f*, *g*, hyphae with clamp connections and haustorial branches. FIG. 4. *Exidia Cokeri.* *a–c*, probasidia and basidia; *d*, *e*, paraphyses; *f*, basidiospores; *g*, basidiospores (two of them septate) germinating. FIG. 5. *Exidia spiculata.* *a–f*, development of the basidia; *g*, paraphysis; *h*, basidiospores, some germinating by repetition; *i*, hyphae with clamp connections; *j*, hyphae swollen at the septa. FIG. 6. *Seismosarca tomentosa.* *a–c*, development of the basidia; *d*, basidiospores; *e*, *f*, paraphyses; *g–j*, gloeocystidia; *k*, hypha with clamp connection. FIG. 7. *Sebacina epigaea.* Basidiospores, some germinating by repetition, some becoming irregular and papillate. FIG. 8. *Sebacina plumbescens.* *a–c*, development of the basidia; *d*, basidiospores; *e*, *f*, paraphyses. FIG. 9. *Sebacina podlachica.* *a–d*, development of the basidia; *e*, paraphysis; *f*, cystidia; *g*, basidiospores, some germinating by repetition. FIG. 10. *Sirobasidium Brefeldianum.* *a–d*, chains of basidia in various stages of development; *e*, basidiospores, some budding out conidia; *f*, paraphysis. FIG. 11. *Dacrymyces abietinus.* Basidiospores. FIG. 12. *Guepinia elegans.* Basidiospores, one producing conidia. FIG. 13. *Guepiniopsis chrysocomus.* Basidiospores, one producing conidia. FIG. 14. *Femsjonia pezizaeformis.* Basidiospores, two producing conidia. FIG. 15. *Tulasnella violea.* *a–c*, development of the basidia; *d*, basidiospores, some germinating by repetition. FIG. 16. *Tulasnella violacea.* Basidiospores, some germinating by repetition.

THE FEULGEN REACTION AS A CYTOLOGICAL TECHNIQUE WITH ALLOMYCES ARBUSCULA

RICHARD C. JONES

THE FEULGEN REACTION: A modified Feulgen technique has been used successfully in staining nuclei of *Allomyces arbuscula*. Experiments have been run for the purpose of determining optimum conditions for fixation, hydrolysis, staining, and bleaching.

TYPE OF FIXATIVE: Four fixatives were tested: Feulgen's, Carnoy's A, Carnoy's B, and a Meve's modification of Flemming's solution. Young plants of *Allomyces* were fixed in each of these four solutions for periods varying from ten minutes to seventy-two hours, and subsequently stained and examined for the quality of fixation. More importance was attached to the proper fixation of nuclei than to fixation of the cytoplasm.

LENGTH OF FIXATION: Young plants of *Allomyces arbuscula* were fixed for periods of 10, 15, 20, and 30 minutes and for 1, 2, 3, 5, 9, 12, 18, 24, 36, 48, and 72 hours in each of the four fixatives. The results showed a maximum fixation attained with a different period for each reagent. Plants fixed in Feulgen's solution showed progressively better results up to about forty-eight hours, after which no noticeable difference could be detected. Material fixed with Carnoy's A appeared to attain a maximum fixation between three and five hours, and here too there was no apparent improvement or deterioration from this point. The optimum period of fixation with Carnoy's B was about two hours, and material which was fixed for more than three hours in the reagent showed signs of overfixation; artifacts were increasingly more frequent in material fixed from three to seventy-two hours. The plants fixed in Flemming's solution (Meve's modification) were, to all appearances, fixed as well in five hours as they were after a longer period, and several hours of fixation beyond this point seemed not to affect the results appreciably.

TYPE OF FIXATION: Material fixed in Feulgen's and Carnoy's B showed in general very satisfactory results. Fixation by Carnoy's A seemed to distort the nuclei causing them to appear abnormally elongate. Meve's modification of Flemming's solution gave generally the poorest results of the four fixatives, the cytoplasm appearing so heavily granular as to interfere with study of the nuclei.

HYDROLYSIS: Satisfactory hydrolysis was obtained with 1.0 normal. When the material is removed from the hydrolyzing agent 0.5 normal hydrochloric acid for 18 to 20 minutes at 58° C. Injury to the hyphae may result if the temperature is allowed to exceed 60° C. or if the concentration of acid is greater than 1.0 normal. When the material is removed from the hydrolyzing agent some shrinkage of cytoplasm can be avoided by dipping the material into cold (room temperature) 1.0 normal hydrochloric acid before placing it in the distilled water rinse prior to staining.

STAIN: Staining solutions were prepared from seven different lots of basic fuchsin. Four of these lots were several years old (their age being figured from their date of purchase); the other three lots were all acquired directly from chemical supply companies. All of the fresh lots gave satisfactory results, but the older lots proved less reliable, two of them being unsatisfactory. However, the oldest lot of all, a fuchsin purchased thirty years ago, gave the most satisfactory reactions.

The effect of the Coleman technique for decolorization was tested for each stain, and although it resulted in complete decolorization in every case, and noticeably improved the staining qualities of the poorest fuchsins, the solutions which gave good stains without it showed no marked improvement as a result of the further decolorization. As a matter of fact, some of the best slides prepared were stained with a clear amber-colored staining solution.

STAINING PERIOD: Vigorous young plants of *Allomyces arbuscula* were stained for periods of 1, 1½, 2, 3, 5, 15, 20, and 30 minutes and for 2, 3, 5, 7, 15, 17, and 24 hours. There seemed to be no danger of overstaining with any of these periods. The intensity of the stain increased visibly up to the five-hour period, and the ability of the nuclei to retain the stain increased up to the ten-hour period. In general it may be said that a long stain of five hours to overnight gave the best results.

BLEACH: The bleaching solution employed in these studies was the sulphur dioxide in water bleach recommended by Johansen (1). Stained plants were bleached for 30 seconds, and for 1, 2, 3, 5, 8, 10, 15, 20, and 30 minutes. For a five-hour stain, it was observed that a quick dip-bleach was sufficient to clear the hyphae, the material being dipped into three successive dishes of the bleaching solution. In no case, even with the twenty-four hour stain, was a bleaching period of greater than five minutes required for satisfactory results.

DEHYDRATION AND MOUNTING: The plants were transferred from the bleach to a distilled water rinse for from ten minutes to overnight, and dehydrated through the following alcohol and xylol series: alcohol 20%, 30%, 50%, 75%, 85%, 95%, 100%, 75% alcohol and 25% xylol, 50% alcohol and 50% xylol, 25% alcohol and 75% xylol, and 100% xylol. The plants were left for at least five minutes in each of these solutions and for ten minutes in the 85%, 95%, and 100% alcohols. The material was then mounted in Canada balsam.

MECHANICAL TECHNIQUE: The numerous transfers of these delicate plants from one to another solution presented a problem in mechanical injury to the hyphae. This problem, however, was solved by the use of a simple instrument, fashioned by fusing the edge of a glass cover-slip to the end of a glass rod in the flame of a bunsen burner. When the angle subtended by the cover-slip was about 115 degrees and the glass rod was held as one would hold a pencil, the cover-slip provided a flat surface onto which the mycelial tuft could be floated by simply bringing the cover-slip up underneath the floating plant. The transfer was then accomplished by floating the plant off into the next solution in the series. In this work, the transfers were made into Stender culture dishes which contained the reagents.

SUMMARY OF STAINING TECHNIQUE:

Feulgen fixation for 48 hours or Carnoy's B for 2 hours.
Rinse in distilled water for 20–30 minutes.
Cold (room temperature) 1.0 normal hydrochloric acid for 5 minutes.
Hot (58° C.) 1.0 normal hydrochloric acid for 5–7 minutes.
Cold (room temperature) 1.0 normal hydrochloric acid for 5 minutes.
Rinse in distilled water for 5 minutes.
Stain in fuchsin sulphurous acid 5–10 hours (or up to 24 hours without danger of overstaining).

Bleach in water containing sulphur dioxide 30 seconds to 5 minutes.
Rinse well in distilled water.
Dehydrate and clear:

5 minutes each in 20%, 30%, 50%, 70% alcohols
10 minutes each in 85%, 95%, 100% alcohols
5 minutes each in 75% alcohol and 25% xylol, 50% alcohol and 50% xylol, 25% alcohol and 75% xylol, and 100% xylol.

Mount in Canada balsam or clarite.

FORMULAE

Fixing Fluids

1. Feulgen's fixative

Corrosive sublimate (6% aqueous solution)	98	parts
Glacial acetic acid	2	parts

2. Carnoy's fluid (A)

100% Ethyl alcohol	15	cc.
Glacial acetic acid	5	cc.

3. Carnoy's fluid (B)

100% Ethyl alcohol	30	cc.
Glacial acetic acid	5	cc.
Chloroform	15	cc.

4. Flemming's solution (Meve's modification)

0.5% Chromic acid	15	parts
Glacial acetic acid	1	part
2% Osmic acid	2	parts

Staining Solution

Basic fuchsin	5	grams
Distilled water	100	cc.
1/N Hydrochloric acid	10	cc.
Potassium metabisulphite	0.5	gram

Dissolve the basic fuchsin by pouring over it the boiling distilled water and shaking thoroughly. Cool to 50° C. and filter. To filtrate add the hydrochloric acid; cool to 25° C. and add potassium metabisulphite. Shake well, stopper tightly, and place in darkness for 18–24 hours.

Bleaching Solution

1.0 Normal hydrochloric acid	5	cc.
10% Aqueous potassium metabisulphite	5	cc.
Distilled water	100	cc.

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DEPARTMENT OF BOTANY,
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DURHAM, NEW HAMPSHIRE

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XLIII. SEAVERINIA

FRED J. SEAVER

(WITH 1 FIGURE)

The species on which the above named genus was founded was first observed by the writer about 1912 in the vicinity of The New York Botanical Garden. It has been observed and collected practically every spring since that time to the present, 1946. The only years in which it was not collected were those in which no effort was made to find it. It occurs from the latter part of April until around the first of June. No collections have been made in June. The fungus is outstanding since it was the first species in which a definite connection was made between a *Botrytis* and a *Sclerotinia*.

HISTORY OF THE FUNGUS

On May 23, 1917, the writer addressed a letter to H. H. Whetzel as follows: "For several years past I have been collecting each spring a *Sclerotinia* on the rootstocks of wild geranium. Perhaps you recall that I referred to this species when you were here. During the present spring I have found it as usual and have been following it up in the field with a hope of finding its conidial stage. I have been unable to find anything which appeared to be its conidial stage on the leaves of the same host. However, I have in culture a number of rootstocks which were infected with apothecia and in about a week I had the most beautiful growth of a *Botrytis*. I am sending a small specimen of this to you for examination. While the occurrence of *Botrytis* might be purely coincidence, it occurs with such great abundance in connection with the apothecia and rootstocks that I am inclined to suspect that there might be some connection between the two. If you can give me any light on the *Botrytis* as to its identity, the favor will be very greatly appreciated."

On May 29, 1917, Whetzel wrote in answer to the above: "I very much doubt that the *Botrytis* can be a conidial stage of your fungus on the wild geranium. Nevertheless this is quite possible, and I shall see what I can make out of it. However, I could come a great deal nearer answering the question if you could get me apothecia of the same fungus from which I could make ascospore cultures. The probability is that cultures from the *Botrytis* will give only *Botrytis*."

In the meantime, W. T. Horne who was doing culture work in the New York Botanical Garden kindly offered to test the *Sclerotinia* spores from which *Botrytis* was obtained in a very few days. On June 26, 1917, the writer wrote Whetzel as follows: "Since writing you we have cultured out the *Sclerotinia* on wild geranium and proved beyond the question of a doubt that the *Botrytis* is the conidial stage of this fungus. Professor Horne is here for a time and being interested he offered to culture the fungus. Excellent growth of conidia can be produced from the ascospores in four or five days. I thought you might be interested in knowing our results. We will publish a short paper in the near future. I would be glad to send you some of the perfect stage of the fungus but the last time I was out I could find none. It lasts only about a month in the spring. Unless we can decide on the specific name of the *Botrytis* we will call the fungus *Sclerotinia Geranii*. According to our rules the specific name of the *Botrytis* provided it has one, would be tenable for the species." This refers to the American rules which were being followed by us at that time. A brief note was published by W. T. Horne and the writer in *Science* (**46**: 163. 1917).

On July 2, Whetzel wrote: "I am delighted to have your letter of June 26. I want to congratulate you upon having made the connection between a *Botrytis* and the *Sclerotinia*. So far as I am aware this is the first authentic case of the connecting up of the *Botrytis* with the *Sclerotinia*, and it will be a very important contribution to the general subject." However, Whetzel was not inclined to accept our report at face value and since the fungus at that time was not known to occur in any other locality he planned to come to New York and study the fungus from fresh material.

On March 24, 1919, Whetzel wrote "I am planning definitely

to come to New York this spring when that *Botrytis Sclerotinia* fungus is fruiting on the rootstocks of the wild geranium. I want to collect some material and make some isolations directly from the fresh stalk. I shall probably want to spend two or three days down there at the gardens working on the thing, will bring along the necessary media for making my isolations. I shall appreciate it if you will let me know as soon as you can just when will be the best time to collect the thing. If you find it appearing, you can telegraph me and I will get down within the next few days. I have a lot of interesting things in connection with *Sclerotinia* and *Botrytis* to talk over with you. We have made some new finds recently that will, I am sure, be of great interest to you."

On April 15, 1919, the writer wrote the following: "Dear Professor Whetzel: I was out through the woods yesterday and found a single cluster of *Sclerotinia* on wild geranium. This would indicate that it is rather early otherwise the fungus would appear in abundance. However, in accordance with your request, I am notifying you as a sort of preliminary report. I should say probably about the first of May it ought to be in good condition."

Accordingly Professor Whetzel was in New York on May 1, 1919, accompanied by Miss Cynthia Wescott who was acting as his assistant at the time. His work substantiated our results in every way.

DISTRIBUTION OF THE FUNGUS

Although this fungus was collected in New York as early as around 1912 and practically every season since in, usually, rather large quantity it had not been observed in any other locality until 1931 when Dr. J. J. Davis sent a small quantity collected by him in Wisconsin.

On May 8, 1932, Whetzel wrote "We were collecting at McLean's last Friday. You will be interested to know that one of the boys discovered a large area in which *Sclerotinia Geranii* was very abundant. It is the first time it has ever been found in the Cayuga flora so far as I know. It is certainly the first time I ever collected it. My memory is that you told me there are only two stations heretofore known for it in the United States, Van

Cortlandt Park and somewhere in Wisconsin. I believe you told me that Dr. Davis had sent you a specimen from Wisconsin. I should appreciate it if you would give me complete information as to where it has been found. I am sending you enclosed a specimen from McLean for your collection."

At the present time after more than thirty years since its discovery this fungus is still known from only three places in the world. It seems especially strange that this cup-fungus which is fairly conspicuous could have been overlooked in the Ithaca section for twenty years with Durand, Whetzel and their students scouring that region for Discomycetes. This leads the writer to suspect that it is a recent introduction, at least in the Ithaca region.

CHARACTERS OF THE GENUS

The *Botrytis,* which represents the conidial stage of the only species known in this genus at the present time, has tuberculate spores whereas all the other species of *Botrytis* known to Whetzel and to us at the time have smooth spores. This together with the absence of a true stroma in the rootstocks of the host led Whetzel to set it apart as a distinct genus. It is not the intention of the writer to discuss the merits of the genus but merely to present the facts and leave the reader to judge for himself. Since this is a monotypic genus, the characters of the species are those of the genus. For a detailed description of the genus see *Mycologia* (**37**: 705). There we find the following statement: "Conidial stage placed originally in the form-genus *Botrytis* by Seaver and Horne but excluded from it by Whetzel because the conidia differ from those of *Botrytis* of the *cinerea* type in being tuberculate." The writer does not agree that the conidial stage should be excluded from the form-genus *Botrytis* because of its rough spores unless a new form-genus be established, for there is no other known form-genus in which it can be placed. The following name is therefore proposed for the conidial stage of the fungus:

Botrytis Geranii sp. nov.

Conidiophoris effusis, brunneis, ramosis; conidiis subglobosis, prima levibus dein verrucosis, pallide brunneis, 10 μ diam.

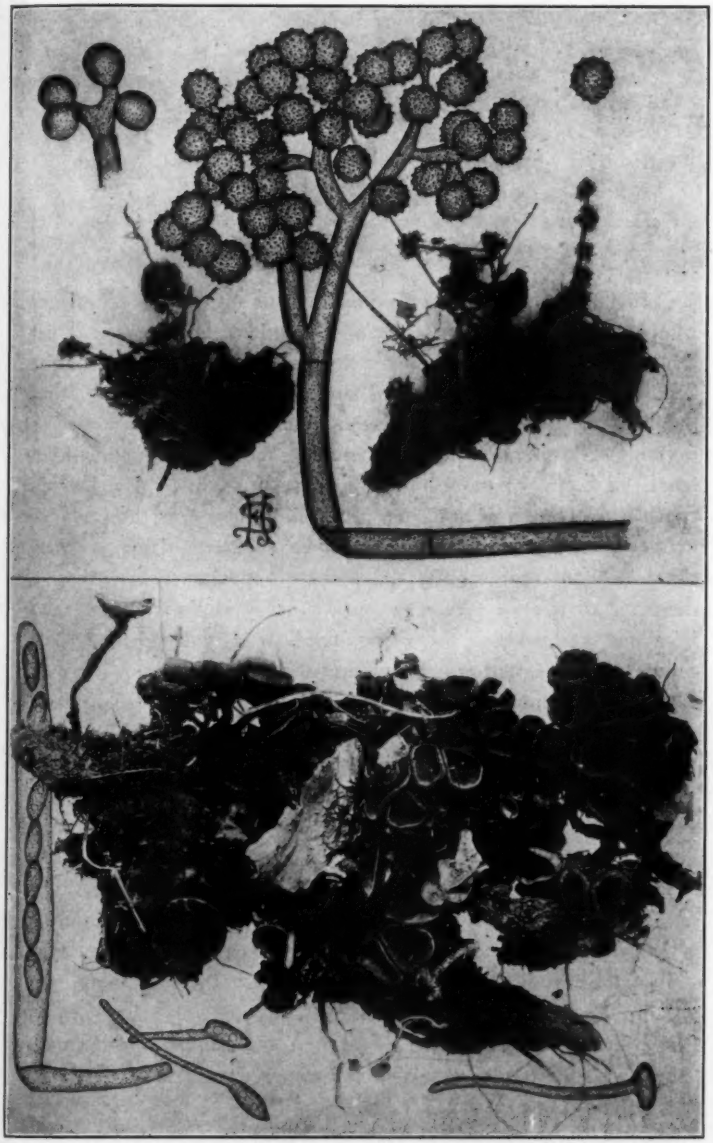

FIG. 1. *Seaverinia Geranii.*

The following is the description and synonymy of the type species:

SEAVERINIA GERANII (Seaver & Horne) Whetzel, Mycologia **37**: 705. 1945.

Sclerotinia Geranii Seaver & Horne, Memoirs Torrey Club **17**: 205–206. 1918.

Stromatinia Geranii Seaver & Horne, Memoirs Torrey Club **17**: 206. 1918.

Conidial stage (*Botrytis Geranii*) occurring on the roots and rootlets of the host, being especially abundant when left in moist chamber for a few days and even developing on the outside of the apothecia, usually appearing in tufts and often springing from minute sclerotium-like bodies although the latter are not always present, dark brown in mass at maturity; conidiophores reaching a length of 1 mm. or more and a diameter of 10–15 μ, pale brown, sparingly septate and branched, the conidia borne in rather large masses like bunches of grapes; conidia subglobose or pyriform, the small end representing the point of attachment, reaching a diameter of 10 μ or rarely as large as 12 μ, slightly longer than broad, at first smooth, becoming quite strongly roughened, pale brown with transmitted light. Apothecia springing from the partially decayed rootstocks in clusters of variable numbers, stipitate, shallow cup-shaped or subdiscoid, reaching a diameter of 1 cm. or rarely larger, pale brown externally; hymenium concave or nearly plane, a little darker than the outside of the apothecium; stem reaching a diameter of 2 mm. and often reaching a length of several cm., though often short and occasionally almost wanting, the length varying with the depth to which the rootstocks of the host are buried; asci cylindric or subcylindric, 8-spored, reaching a length of 120–140 μ and a diameter of 8–10 μ; ascospores hyaline, ellipsoid or almond-shaped, 4–5 $\times$ 12 μ, usually containing two small oildrops (FIG. 1).

On the rootstocks of wild geranium (*Geranium maculatum*). The type collected in woods in the upper end of Van Cortlandt Park, New York City, 1917.

DISTRIBUTION: New York and Wisconsin.

ILLUSTRATIONS: Memoirs Torrey Club **17**: *p. 13;* Mycologia **37**: 704, *f. 32, 33.*

NEW YORK BOTANICAL GARDEN,
BRONX PARK, NEW YORK

EXPLANATION OF FIGURE 1

Above, photograph of clumps of *Botrytis* on the underground parts of wild geranium, natural size, with drawings of conidiophores, and conidia enlarged.

Below, photograph of a clump of apothecia, natural size, with drawing of ascus with ascospores and several germinating ascospores, much enlarged.

All drawings made with the aid of the camera lucida to a common scale.

ANOTHER GYMNOSPORANGIAL CONNECTION

FRANK D. KERN AND ERDMAN WEST

(WITH 3 FIGURES)

Cultural proof of heteroecism in the Uredinales was made by deBary in 1864 and the fact that species of *Gymnosporangium* were heteroecious was proved very soon afterwards. In the spring of 1865 Oersted demonstrated by controlled inoculations the connection between *Gymnosporangium Sabinae* on red cedar and *Roestelia cancellata* on pear. During the next two years Oersted proved the life-history of *Gymnosporangium juniperinum* and of *Gymnosporangium clavariaeforme*. We are indebted to Oersted as well as to deBary for pioneer work with the heteroecious rusts.

Since those early days cultures by different workers have demonstrated the life-histories of many other species of *Gymnosporangium*. The telial stages are on members of the cedar family, Juniperaceae. For many species the aecial stages were found to occur on members of the apple family, Malaceae. At one time it was thought safe to conclude that the species of *Gymnosporangium* inhabited only hosts belonging to the families Juniperaceae and Malaceae. No telial stages have been found outside the Juniperaceae but aecial stages of three species are now known to be on hosts belonging to the Rosaceae, Hydrangiaceae, and Myricaceae, respectively.

There are a few species on the members of the apple family having cupulate aecia and aeciospores with pale yellow walls. The majority of these species, however, have aecia with a cylindric or cornute peridium, peridial cells with walls variously sculptured, and aeciospores with deeply colored walls. In general these are the characteristics of the form-genus *Roestelia*.

Two species of *Roestelia* have stood apart from the majority in having smooth peridial cells. One of these was described by Schweinitz as *Caeoma* (*Roestelia*) *Botryapites* on *Amelanchier*

canadensis. In 1886 Thaxter (Bot. Gaz. **11**: 236) established the relationship between this *Roestelia* and *Gymnosporangium biseptatum* Ellis on *Chamaecyparis thyoides*.

The other species, having smooth peridial cells, was named *Roestelia hyalina* by Cooke in 1877 (Bull. Soc. Bot. Fr. **24**: 315) from a specimen on *Crataegus* from South Carolina. For many years nothing further was known about this species. It did not appear in mycological collections and we find no published references to it until 1910. In that year the senior author reported (Science **31**: 832) finding it on some herbarium specimens at the New York Botanical Garden and the Arnold Arboretum. This discovery showed that its occurrence was not rare and extended the range northward to North Carolina and southward to Florida. The ten species of *Crataegus* on which it was found are listed in "A Biologic and Taxonomic Study of the genus Gymnosporangium" (Kern, Bull. N. Y. Bot. Garden **7**: 470. 1911); in the North American Flora (**7**: 207. 1912); and in Arthur's Manual of the Rusts of the United States and Canada (p. 361. 1934).

In the Science paper, quoted in the foregoing paragraph, which was entitled "Prediction of Relationships among some Parasitic Fungi," the senior author speculated on the life-history of *Roestelia hyalina* on *Crataegus*. It was there pointed out that it had two striking characters in common with *Roestelia Botryapites* on *Amelanchier*, (1) the entirely smooth walls of the peridial cells, and (2) the small wart-like protuberances in which the peridia are borne, and the conclusion was that these two forms might be related to similar telial stages. Since *R. Botryapites* was known to be connected to *G. biseptatum* on white cedar (*Chamaecyparis thyoides*) the prediction was that *R. hyalina* ought to alternate with a telial stage on the white cedar and an argument was presented in favor of the only other rust then known on that host, *G. Ellisii*. However, in 1914 Fromme established the relationship of *G. Ellisii* with an aecial stage on *Myrica*. In 1911 the senior author described another rust on white cedar, *G. fraternum* (Bull. N. Y. Bot. Garden **7**: 439). In 1916 Dodge demonstrated that *G. fraternum* has *R. transformans* on *Aronia* as its alternate stage (Bull. Torrey Club **45**: 297. 1918).

As we resumed interest several years ago in *Roestelia hyalina* on *Crataegus* we were mindful of the white cedar hypothesis. The three species of *Gymnosporangium* then known on white cedar being associated with aecia on *Amelanchier, Myrica,* and *Aronia,* it was obvious that a new one had to be discovered if that hypothesis were correct.

The first field observations were made in South Carolina. In the summer it was easy to find *R. hyalina* on *Crataegus* in the region of Aiken. *Chamaecyparis* was not found growing in the vicinity of the *Roestelia* and there arose a considerable doubt about the probability of its being the alternate host. A gall form on red cedar was found which was thought to be a possibility. It resembled *Gymnosporangium globosum* but seemed to have minor differences which we thought might be significant. In 1940, the same form was found near Bristol, Florida, where *R. hyalina* is commonly present on *Crataegus quaesita* later in the year. At least two seasons were lost while we were settling the identity of this form on red cedar. Cultures finally proved that it was *G. globosum.*

During the war period field work was impossible. In the spring of this year, 1946, we returned to the field convinced that a further search would yield a telial stage on white cedar which would turn out to be the alternate stage of *R. hyalina.* This time we were rewarded. On March 4 the authors, in company with Dr. C. R. Orton, collected at Bristol, Florida, a fine new *Gymnosporangium* on *Chamaecyparis.* Two days later the senior author and Dr. Orton collected the same form in the vicinity of Aiken, South Carolina. We should explain that we had investigated in the meantime the distribution of *Chamaecyparis* and had found that it was known to occur in all the regions of North Carolina, South Carolina, and Florida where the *Roestelia hyalina* was known. Cultures from both the Florida and the South Carolina specimens have produced this *Roestelia* on undetermined species of *Crataegus* in the greenhouses at State College, Pennsylvania. Cultures from the Florida specimens gave positive results on *Crataegus rimosiformis* Murr. and on *C. uniflora* Muenchh. at Gainesville, Florida.

It is true that the name *Roestelia hyalina,* according to the inter-

national rules, applying to an aecial "state" had only a "temporary value." It was certain, however, that this aecial "state" would eventually have a "perfect state" in the genus *Gymnosporangium*. In order that it might be included in a monographic presentation with other species of the genus the combination, *Gymnosporangium hyalinum*, was used in the paper "A Biologic and Taxonomic Study of the Genus Gymnosporangium" (Bull. N. Y. Bot. Gard. **7**: 470. 1911). We now have the telial stage ("perfect state") and are supplying the description which makes the name *Gymnosporangium hyalinum* valid. The complete record is as follows:

Gymnosporangium hyalinum [Cooke] Kern, Bull. N. Y. Bot. Gar. **7**: 470. 1911. (FIG. 1.)

Roestelia hyalina Cooke, Bull. Soc. Bot. Fr. **24**: 315. 1877.

Aecidium hyalinum Farlow, Bibl. Index **1**: 55. 1905.

Pycnia epiphyllous. Aecia hypophyllous, on small gall-like pyriform protuberances, consolidated at the bases, cylindric, 2–5 mm. high, tardily rupturing along the sides, somewhat distorted but not recurved, the peridial cells lanceolate in face view, remaining straight when wet, outer wall 12–16 μ thick, inner and side walls 3–4 μ, smooth on all surfaces; aeciospores globoid, 19–26 μ in diameter; wall light cinnamon-brown, 2–3 μ thick, finely verrucose, the pores 6–8.

Telia caulicolous, usually on areas extending along the smaller woody branches for 3–6 mm., not causing much swelling, sometimes among the leaves on the green branches, or breaking forth through the bark on larger branches, pulvinate, scattered or usually aggregated, varying in shape and size, 1–5 mm. across or appearing larger by becoming confluent, light chocolate-brown; teliospores 2-celled, ellipsoid, 16–21 × 40–63 μ, slightly constricted at the septum; wall golden-brown, 1–1.5 μ thick, thicker at apex, up to 3–4 μ; pores one in a cell, apical; pedicels cylindrical, 3–5 μ in diameter, moderately long.

HOST PLANTS:

For the aecia: *Crataegus clara* Beadle, Fla.—*C. dispar* Beadle, S. C.—*C. egens* Beadle, Fla.—*C. egregia* Beadle, Fla.—*C. Michauxii* Pers., S. C.—*C. munda* Beadle, N. C.—*C. pexa* Beadle, N. C.—*C. quaesita* Beadle, Fla.—*C. viridis* L., N. C., S. C.—*C. visenda* Beadle, Fla.—*Pyrus communis* L. × *P. pyrifolia* (Burm.) Nakai, Fla.

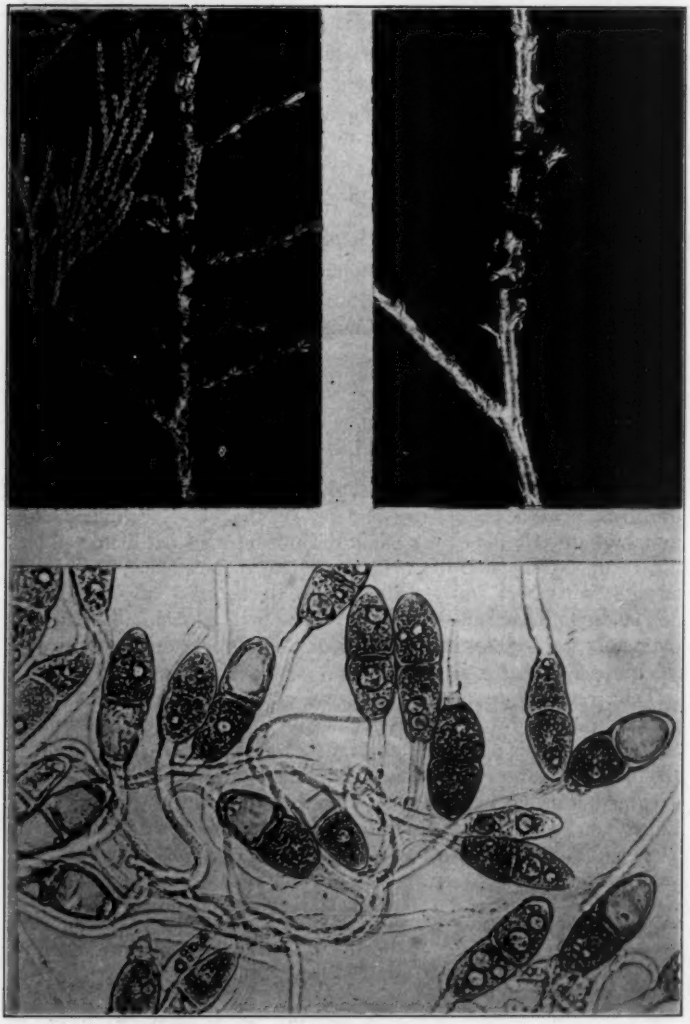

FIG. 1. *Gymnosporangium hyalinum.*

For the telia: *Chamaecyparis thyoides* (L.) B. S. P., 3½ miles east of Bristol, Fla., March 4, 1946, *F. D. Kern, C. R. Orton, E. West;* Congaree Creek, West Columbia, S. C., March 6, 1946, *F. D. Kern, C. R. Orton.*

THE PENNSYLVANIA STATE COLLEGE,
THE FLORIDA AGRICULTURAL EXPERIMENT STATION

ILLUSTRATIONS

Gymnosporangium hyalinum; above, showing distribution of the telia on branches of *Chamaecyparis thyoides;* below, photomicrograph of the teliospores.

NOTES AND BRIEF ARTICLES

Viability of Some Mold Cultures

Since there are many laboratories in which a few mold cultures are kept and where no facilities are available for using the lyophil process described by Raper and Alexander [1] for the preservation of mold cultures, it seems warranted to record the following observations since they cover a fairly large number of organisms over a long period of time.

In May 1943 a number of cultures were placed on potato dextrose agar. Care was taken that good sporulation was obtained and that the spores were fully mature before the cotton plugs were ringed with a mixture of glycerol, arsenic and mercuric chloride, placed in baskets and stored in a cold room where the temperature was maintained at approximately 7 degrees C. It was not until January 1946 that the cultures were again transferred. At this time all cultures appeared to be completely dried down but a great many were found to be viable. During my absence in the military service a few cultures were accidently removed and lost. These are listed separately from the nonviable cultures. It should be stated that in a number of cases there are duplications of species. The last group listed as, "others," refers to a number of cultures in which only one of a genus was present or had not been determined. For convenience sake these were summarized under one heading. No attempt was made to determine if there had been any physiological change. The following table shown at top of page 127 summarizes the results.

An interesting thing noted in the genus *Aspergillus* was that species of some sections were definitely more resistant than others. In the *Aspergillus niger* group only two cultures grew out of fourteen, in the *A. wentii* group five were dead out of six, in the *A. flavus-oryzae* group four were dead out of five. On the other hand,

[1] Raper, K. B. and D. F. Alexander. 1945. Preservation of molds by lyophil process. Mycologia **37**: 499–525.

Genus	No. Viable	No. Nonviable	Lost
Mucor	53	1	5
Phycomyces	3	0	0
Rhizopus	13	3	1
Absidia	8	2	0
Circinella	2	0	0
Sporodinia	0	1	0
Mortierella	17	3	2
Haplosporangium	6	1	0
Pilaira	0	1	0
Helicostylum	3	0	0
Thamnidium	2	0	0
Zygorhynchus	5	0	0
Cunninghamella	9	4	0
Syncephalastrum	2	0	0
Syncephalis	0	2	0
Actinomucor	1	0	0
Piptocephalis	0	1	0
Mycotypha	0	1	0
Aspergillus	48	46	4
Penicillium	159	3	2
Fusarium	11	1	3
Trichoderma	7	0	0
Chaetomium	7	1	0
Alternaria	3	0	0
Others	50	12	1
Totals	409	83	18

Total number of cultures reported on, 510.
Total age of cultures, 2 years 8 months.

A. fumigatus and *A. fischeri* group showed the opposite. Of the four cultures of *A. fumigatus* all were alive, while *A. fischeri* showed all eight cultures to be viable. In the *A. versicolor* group all five cultures were viable.

A second set of cultures which were transferred in the summer of 1944 during my absence were tested for viability during February 1946 which represented a period of 19 months. The results were comparable to those above in that the same highest percentage of nonviable cultures were among the Aspergilli and a very low nonviable number of cultures appeared for *Penicillium* and the *Zygomycetes*. For example among the Aspergilli eight were nonviable out of eightly-two. Of course one would expect a greater number of cultures to be alive, which was the case. It is noteworthy that among these were such species as *Pilaira anomala, Sporodinia grandis* and *Mycotypha microspora,* all having been found dead at two years eight months.

It seems especially important among the *Zygomycetes* to observe, prior to storage, that one makes certain that sporulation has been vigorous and that the spores are fully mature since too hasty storage seems to shorten viability. Secondly any culture suspected of being contaminated with *Penicillium* or *Aspergillus* should be reisolated or kept under observation since often a contaminated culture will prove to be dead.

I wish to thank Dr. E. M. Gilbert for making this work possible and for his helpful suggestions.

C. W. HESSELTINE

SCREENING TESTS FOR ANTIBIOTICS

Several thousand microörganisms have been isolated from many sources and tested for antibiotic activity. These microörganisms include fungi, bacteria, Actinomycetes and algae. Mud from the river banks collected immediately after floods was found to be an excellent source of active organisms.

Screening tests for antibiotic activity toward numerous bacteria were conducted using the following medium. All test organisms grew well, and antibiotic compounds were readily produced by this medium.

Dextrose	10.0 grams
Peptone	5.0 grams
Beef extract	3.0 grams
NaCl	5.0 grams
Agar	15.0 grams
Tap or distilled water	1.0 liter

pH adjusted to 7.5 with NaOH before sterilization

1. *Cross-Streak Agar Method*

This method is a slight modification of Garrè's [1] and Fleming's [2] streak methods. In the present work the test consisted of streaking with a wire loop the microörganism to be tested at one side of

[1] Garrè, C. Ueber Antagonisten unter den Bacterien. Correspondenz-Blatt für Schweizer Aerzte 17: 385–392. 1887.

[2] Fleming, A. In vitro tests of penicillin potency. Lancet 1: 732–733. 1942.

the agar plate or across its center. A loop-full of thoroughly wetted spores was used to make the streak, to avoid scattering dry and powdery spores over the agar. The cultures were allowed to grow three to five days at room temperature. Usually three days was enough time for any active organism to produce the antibiotic substance which will diffuse into the agar medium. The bacterial testers (using gram-positive and gram-negative bacteria including some human and animal pathogens) were streaked perpendicular to the master streak, without mixing. The bacterial streaks were started close to the master streak then drawn toward the edge of the plate without touching it or breaking the agar. Ruled paper under the plates was used to facilitate streaking. Afterwards the plates were incubated at room temperature (70–90° F.) or at 37° C., sixteen to twenty-four hours and the results observed. Inactive organisms allowed the tester to grow up to the master streak, while the active organisms inhibited the testers in varying degrees. Small petri plates (100 × 20 mm.) containing 20 cc. of medium and large plates (150 × 20 mm.) containing 40 cc. of medium were used. Large plates were more satisfactory when 16 or 20 different bacterial testers were used. Care was taken to select plates with flat bottoms, and not to draw the master streak until the surface of the agar was dry in order to avoid unnecessary spreading of the organism to be tested.

The plates containing active organisms should be kept for several days to determine whether the testers make further growth toward the master streak, whether they remain stationary, or whether lysis of the bacterial testers occurs. It has been found that when the testers grew all the way toward the master streak, the organism was usually void of an antibiotic and was not satisfactory in further work.

Among many bacterial testers used, the following were found useful in the search for organisms with antibiotic activity:

Staphylococcus aureus ATCC No. 6538
Bacillus subtilis ATCC No. 6633
Escherichia coli ATCC No. 9637
Mycobacterium tuberculosis var. *hominis* ATCC No. 607
Bacillus mycoides, Turtox Biol. Supply House, Chicago
Serratia marcescens, Turtox Biol. Supply House, Chicago.

The bacterial testers were grown for one or more days at room temperature or 37° C., on plates or slants of nutrient agar. The growth was scraped off and well mixed in sterile water to make a heavy suspension. Care was taken to scrape off only the bacterial cells and not agar. The testers were also grown in shallow layers of nutrient broth. After seeding, it was sometimes found desirable to shake the flasks occasionally or to set them on a shaker until a heavy suspension of cells was obtained.

2. Smearing or Flooding Method

Large as well as small plates were used. The organism to be tested was usually streaked on the agar across the plate passing through its center, and then it was allowed to grow at room temperature for about three days. Then each side of the central streak was smeared or flooded with one or two different testers suspended in sterile water or any other liquid. Usually a gram-negative tester was used on one side and a gram-positive on the other side. When two different testers were used, one side of the plates was flooded first and the excess pipetted off, and as soon as its surface was dry, the other side was seeded in a similar fashion. The plates were then incubated for 16 to 24 hours usually at 37° C.

The flooding technique has been used with helpful results for permanent records. The zone of inhibition (where antibiotic compounds are present) was quite constant for each test organism and for each tester under comparable conditions of media, age, temperature, pH, etc.

The flooding method was used for those organisms which were found to be active and promising by the cross-streak agar method.

A correlation has been found for active organisms between the results obtained with these two methods and the results obtained from shake flasks, aerated bottles, and submerged cultures. Examples of these are *Streptomyces griseus* for the production of streptomycin; *S. lavendulae* for the production of streptothricin and *Penicillium chrysogenum* for the production of penicillin.

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STUDIES IN SCIENCE

Under this title, the University of North Carolina has issued a volume of sesquicentennial publications. All the papers in this volume are original publications of members of the Elisha Mitchell Scientific Society and were first published in the journal of that society as volume 61.

The volume contains the following botanical articles: Penicillin: V. Mycological aspects of penicillin production by Kenneth B. Raper and Dorothy F. Alexander; Nutritional studies of representatives of five genera in the Saprolegniaceae by Alma J. Whiffen; and Revision of the genus *Coleomyces,* parasitic in insect larvae by J. N. Couch.

The entire volume comprises 375 pages, twelve plates and a number of text figures neatly bound in board covers and can be obtained from the University of North Carolina Press.

FRED J. SEAVER

GEORGE GRANT HEDGCOCK

The death of George Grant Hedgcock at the age of 82 occurred near Washington, D. C., on May 11, 1946, after a long illness. Dr. Hedgcock was a pioneer worker in the field of forest pathology and related mycological problems. His work in these fields commenced in 1902 at the Mississippi Valley Laboratory of the Bureau of Plant Industry at St. Louis, where he was particularly concerned with the crowngall diseases of fruit trees and the wood staining fungi. Of the latter he described a considerable number of new species.

After transferring to the Washington office of the then Office of Forest Pathology of the Bureau he was engaged in forest tree disease surveys for some years. In the course of this activity he made the extensive collections of fungi particularly of rusts and wood rotting species which form the basis of the present mycological reference herbarium of the Division. In his latter years he carried on an intensive study of forest tree rusts, especially of the genera *Coleosporium* and *Cronartium,* including life-history studies, and description of new species. His studies in this field were in collaboration with his colleagues, Ellsworth Bethel, W. H. Long, and N. R. Hunt, and resulted in an extensive series of

publications. More than 100 titles are included in his complete bibliography.

Dr. Hedgcock's private fungus herbarium is being incorporated into the Mycological Collections of the Bureau of Plant Industry. —JOHN A. STEVENSON.

NEW COMBINATIONS

The following species described by me under *Cortinaria* and *Lactaria* in MYCOLOGIA, Lloydia and the Torrey Bulletin from 1938 to 1945 are here recombined under *Cortinarius* and *Lactarius* for the convenience of those who prefer to use the masculine form of the generic names.

CORTINARIA ALBIDIFORMIS Murr.	= **Cortinarius albidiformis** Murr.
CORTINARIA AMARISSIMA Murr.	= **Cortinarius amarissimus** Murr.
CORTINARIA ATRIBADIA Murr.	= **Cortinarius atribadius** Murr.
CORTINARIA CAMPESTRIS Murr.	= **Cortinarius campestris** Murr.
CORTINARIA CITRINICEPS Murr.	= **Cortinarius citriniceps** Murr.
CORTINARIA CYLINDRISPORA Murr.	= **Cortinarius cylindrisporus** Murr.
CORTINARIA DEFLEXA Murr.	= **Cortinarius deflexus** Murr.
CORTINARIA EQUESTRIFORMIS Murr.	= **Cortinarius equestriformis** Murr.
CORTINARIA FIMBRIATA Murr.	= **Cortinarius fimbriatus** Murr.
CORTINARIA HEBELOMOIDES Murr.	= **Cortinarius hebelomoides** Murr.
CORTINARIA LACTICEPS Murr.	= **Cortinarius lacticeps** Murr.
CORTINARIA LARGIFORMIS Murr.	= **Cortinarius largiformis** Murr.
CORTINARIA OREADES Murr.	= **Cortinarius oreades** Murr.
CORTINARIA PERVIOLACEA Murr.	= **Cortinarius perviolaceus** Murr.
CORTINARIA PRIVIGNIFORMIS Murr.	= **Cortinarius privigniformis** Murr.
CORTINARIA PUSILLA Murr.	= **Cortinarius pusillus** Murr.
CORTINARIA SQUALIDIFORMIS Murr.	= **Cortinarius squalidiformis** Murr.
CORTINARIA SUBCAMPHORATA Murr.	= **Cortinarius subcamphoratus** Murr.
CORTINARIA SUBFIMBRIATA Murr.	= **Cortinarius subfimbriatus** Murr.
CORTINARIA SUBGLOBISPORA Murr.	= **Cortinarius subglobisporus** Murr.
CORTINARIA SUBLILACINA Murr.	= **Cortinarius sublilacinus** Murr.
CORTINARIA VISCIBADIA Murr.	= **Cortinarius viscibadius** Murr.
CORTINARIA WATSONII Murr.	= **Cortinarius Watsonii** Murr.
CORTINARIA WEBERI Murr.	= **Cortinarius Weberi** Murr.
LACTARIA ALACHUANA Murr.	= **Lactarius alachuanus** Murr.
LACTARIA AMARISSIMA Murr.	= **Lactarius amarissimus** Murr.
LACTARIA ARCUATA Murr.	= **Lactarius arcuatus** Murr.
LACTARIA AVELLANEA Murr.	= **Lactarius avellaneus** Murr.
LACTARIA BUCKLEYANA Murr.	= **Lactarius Buckleyanus** Murr.
LACTARIA NONLACTIFLUA Murr.	= **Lactarius nonlactifluus** Murr.
LACTARIA PARADOXIFORMIS Murr.	= **Lactarius paradoxiformis** Murr.
LACTARIA PARVULA Murr.	= **Lactarius parvulus** Murr.
LACTARIA PRAEVISCIDA Murr.	= **Lactarius praeviscidus** Murr.
LACTARIA PRAEZONATA Murr.	= **Lactarius praezonatus** Murr.
LACTARIA SUBLATA Murr.	= **Lactarius sublatus** Murr.
LACTARIA SUBTESTACEA Murr.	= **Lactarius subtestaceus** Murr.
LACTARIA TORMINOSA GLABRA Murr.	= **Lactarius torminosus glabrus** Murr.
LACTARIA WESTII Murr.	= **Lactarius Westii** Murr.

W. A. MURRILL